Presented by ...

AMERICAN v. ENGLISH

LOCOMOTIVES.

CORRESPONDENCE,

CRITICISM AND COMMENTARY

RESPECTING

THEIR RELATIVE MERITS.

35

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AMERICAN AND ENGLISH LOCOMOTIVES

(Correspondence Respecting the Relative Merits of).

Presented to both Houses of the General Assembly by Command of His Excellency.

The Agent-General, London, to the Hon. the Colonial Secretary, Wellington.

7, Westminster Chambers, London, S. W. 6th November, 1878.

Sir:—I have the honor to enclose, for the information of the Government, copy of a communication by Mr. R. M. Brereton* on the subject of the superior working results of American locomotives as compared with English railway experience, together with an extract from a letter written by Mr. W. W. Evans to Mr. Higinbotham, Engineer-in-Chief in Victoria, relating to American engines.

I have, &c.,

JULIUS VOGEL,

The Hon. the Colonial Secretary. *Agent-General.*

Mr. Brereton to the Agent-General, London.

Dear Sir: I have the pleasure to send you the following statements in reference to the superior working results obtained from American locomotives as compared with our English railway experience. I can guarantee the correctness of the statements, as they have been a source of careful observation and study by me during the past eight years.

During the past twenty-six years I have spent fourteen years

*Mr. Brereton was the Engineer-in-Chief of the Great India Peninsula Railway.

in India, in the construction and working of one of the principal guaranteed railways, besides four years in this country, and nearly eight in the United States, so that I am able to compare the working results in each country from the standpoint of experience. I have come to the conclusion that we can and ought to construct, equip, and work our railway system in India, in our several colonies, and in this country too, in a far more economical manner than past experience *here* has shown to be possible, or our consulting engineers, managing directors, and agents (who have not had the opportunity of studying the working of the 77,470 miles of railway of the United States) have hitherto believed to be possible.

In regard to locomotives, the Americans certainly obtain from 8,000 to 10,000 train-miles greater duty per annum than we can in this country or in India, and this too under the following drawbacks: Inferior roadbeds, steeper gradients, sharper curves, more severe climate, heavier loads hauled, and less speed in running.

The greater duty obtained cannot be due to better workmanship and superior materials, because it is well known that the English mechanic in skill of hand cannot be excelled, and the very best materials are employed by our English builders, and the hours of work in both countries are nearly the same. Hence, I argue that the greater duty done by the American motor is due to the better design and the better system of working the locomotives. The American builder excels in the system of framing and counterbalancing, and in the designs of the crank, axles, &c., so that the engine may run remarkably easily and without jar round sharp curves, and work not only the light roads, but also diminish the wear and tear on the solid roads, and, at the same time, increase the effective tractive force.

The English engine is a very heavy affair, and, in running, it not only wears and tears itself very rapidly, but also the roadway, and it greatly, by its unsteadiness and jar, fatigues the drivers and firemen. I have ridden hundreds of miles on engines in India, in England, in France, and in the United States, and I have always found the American engine most easy and comfortable, but I never did the English or the Continental engines. As an evidence of this unsteadiness in English-built engines, I may quote the following from the *Railway Service Gazette re* "Narrow-Gauge Engines in India:"—

"The speed on all narrow-gauge lines in India is restricted to fifteen miles an hour, and to run trains on our 3-ft. 3-in. gauge railways at a much higher speed is not safe, owing chiefly to the unsteadiness of the locomotives employed. The wheel-base is rigid, the whole engine is stiff, and, the weight not being equalized, through these and other causes they are very unsteady, the oscillation is very great, and the rigid wheel-base jars going round the sharp curves of the metre gauge. It is also almost impossible to give these engines their full hauling power, simply because the greater portion of the weight cannot be thrown on the driving-wheels."

Another point I have to make is the mistake we make in adhering so obstinately to our old-fashioned system of running the engine with only one crew. Every one who understands the construction and powers of the engine must see that it is capable of a far higher average annual duty than 16,000 to 20,000 train-miles. The engine should be kept in steam as long as possible, in order to avoid the wear and tear due to expansion and contraction which ensue under the present system of daily drawing the fires. The continuous running system would save considerably the present consumption of fuel in the daily getting up steam. They do not find in America that the double-crew system involves any greater cost in repairs and renewals; indeed the life of their engines compares most favorably with the life of engines in this country and on the Continent.

The duty of the driver is to run his engine and keep her in order on his daily trip from depôt to depôt; he has nothing to do with her in the stable or depôt; there she is cleaned, repaired, and got in steam by other hands employed for that purpose. When one crew have taken the engine over their daily stage, another crew run her on, and so they oscillate to and fro, the engine stopping only for repairs and to be washed out. Mr. Juland Danvers's report for 1876–77 shows (on page 11) the number of engines on the whole of the guaranteed railways in India to be 1,425, and (on page 31) that the train-miles were 21,609,411, which gives an average of only 15,164 miles per engine. Deducting say 33 per cent. from the days of the year for the monsoon season, and for repairing-days, there are then 240 days in which the engine should be capable of running 100 to 200 train-miles per 24 hours, or from 24,000 to 36,000 train-miles per annum. Mr. Danvers's report, however, shows

that the average mileage per engine was only about 60 miles per 24 hours for, say, 240 days.

From the official returns of the Hudson River Railway, I find that thirteen of the engines in 1877 made a combined monthly average of 6,238 miles for the entire year; four of these ranging from 7,104 to 7,218 miles per month, while the average for the year of all the 97 engines in service was 38,422 miles per engine. One engine in 15 months averaged 7,858 miles per month, or over 255 miles daily for 461 consecutive days, including Sundays. The total life of these thirteen engines was 98½ years, which gives 39,948 miles per annum for each engine for their entire life. The cost of these engines in repairs per mile run was $2\frac{7}{10}$ cents, which is equal to less than $1\frac{4}{10}$ pence per mile. Mr. Ely, the Locomotive Superintendent of the Pennsylvania Railroad, gives the following data in reference to twenty of their engines on the heaviest portion of their system over the Alleghany Mountains for the year 1877:—Ten passenger engines' average annual mileage was 45,554½, and cost of repairs per mile run was 3.48 cents; ten goods engines' annual mileage was 32,574½ and cost of repairs per mile was 3.65 cents; general average of all twenty engines was 39,065½ miles per engine, and cost of repairs per mile run 3.56 cents. One of their passenger engines, No. 133, averaged 237½ miles daily for an entire year (1872). This engine ran, in 1869, 44,616 train-miles; in 1870, 42,900; in 1871, 54,139; in 1872, 86,724; in 1873, 41,979; and in nine years' run it averaged 47,528 per year. Another of their passenger engines, No. 914, ran, in 1874, 60,604 train-miles; in 1875, 58,344; in 1876, 57,225; in 1877, 49,257. A goods engine, No. 447, ran, in 1870, 41,184 train-miles; in 1871, 44,108; in 1872, 42,537; in 1873, 36,877; in 1874, 35,580; in 1875, 36,508; in 1876, 45,529; in 1877, 39,193. This makes an average of 40,189 miles for each of the eight years this engine has been running. On the Erie Railway, Mr. H. J. Jewett, in an official letter, dated 8th April, 1878, gives the following mileage of four engines built by the Rogers Locomotive Works, of Paterson, New Jersey:—

	Mileage.		Placed in Service.
Engine No. 201....	635,169	....	9th June, 1854
Engine No. 202....	632,548	....	26th June, 1854
Engine No. 203....	658,548	....	15th July, 1854
Engine No. 204....	539,186	....	29th July, 1854

These engines had new boilers in 1871, the original boilers

running seventeen years. He reports these engines good for eight years' more service at least. He also reports two other Rogers engines, No. 313 and 327, as running with their original fire-boxes since 1865, or thirteen years. The above-mentioned mileage gives an average for the twenty-four years of 25,677 miles per engine. You will observe that these engines on the different railroads must have been well constructed in the first instance, that they could not have been long in the repairing shops, and that they must have been kept in good running order notwithstanding the high duty they actually performed. This is really very remarkable, when you consider the very severe winters of the Middle States, and how destructive snow is to machinery, as well as Jack Frost, when it breaks up in the spring.

In order to arrive at a fair comparison with the cost of repairs in England, there are a number of points which should be equated, such as cost of labor and materials, effects of climate, steeper gradients, sharper curves, and heavier loads hauled, as in all these the American engines labor under greater disadvantages than engines in this country or in India. The Americans economize far more than we do in the first cost, and in repairs and renewal, by adopting a system of interchangeability of parts as much as possible, and by limiting the number of types or classes of engines. It may be said that for all ordinary traffic requirements of any railway system three types are sufficient. The Americans have perfected the three classes known as C, D, and E. Class C is for passenger service, and for level lines, or where the gradients are easy; Class D, known as the "Mogul," for goods and for heavy gradients; Class E, known as the "Consolidation," for roads having exceptionally heavy gradients, or a very large traffic to be hauled. The passenger engine has a four-wheeled truck, which not only swivels, but can move laterally under the front end of the engine by means of a swinging bolster; it can adapt itself to the shortest curves in use on railways, and to the greatest inequalities in the road. The four driving-wheels are equalized together, as also are the four truck wheels. In the goods engine the same arrangement for swinging trucks is found. The truck is composed of only one pair of wheels. On the Lehigh Valley Road, where there is a heavy coal traffic, gauge 4-ft. 8½ in., Class E works over maximum grades of 126 feet per mile, with a maximum load of 329 gross tons of wagons and loading, and the

usual load is 235 gross tons. On a gradient of 76 feet per mile, one of these engines draws a maximum load of 140 empty four-wheeled wagons (476 gross tons) at a speed of eight miles per hour. The usual train is 100 wagons (340 gross tons) on an incline three miles in length, with a gradient of 96 feet per mile, combined with frequent curves of 8 and 10 degrees radius, and with only two tangents, each less than a mile long. Engines of this class (E) take forty loaded four-wheeled wagons, which are hauled at a speed of twelve miles per hour. The wagons weigh each 3 gross tons 8 cwt., and carry each six gross tons of coal; so that these engines haul up the above incline a train weighing from 329 to 376 gross tons. They consume 3¾ tons of coal daily.

On the Denver and Rio Grande Railroad 3-ft. gauge, where the maximum gradients are 4 per cent. or 211 feet per mile, and the sharpest curves 30 degrees or 193 feet radius, and where the rise in 14.7 miles is 2,370 feet, and in 10.8 miles 1,136 feet, this class (E) of engines hauls one luggage-van and seven passenger carriages, containing 160 passengers, weighing 100 tons, stretched over a length of 360 feet.

On another narrow-gauge road where the maximum gradient is 140 feet per mile, 3 miles in length, combined with several curves of 574 and 478 feet radius, one of 338 feet, and several reverse curves of longer radius, the regular load of these engines (Class 10/24 E), at a speed of 12 miles an hour, is fifteen coal wagons, weighing 9,500 lbs. each, with passenger carriages weighing 18,000 lbs., making total load, exclusive of tender, of 81¼ tons. As regards train-mileage, the following comparative statement, showing working results on English, American, and Indian railroads for the year 1876–77, will prove interesting and instructive:

English.	*No of Engines.*	*Miles operated.*	*Train-miles per engine.*
Great Western	1,478	2,274	17,397
Great Eastern	505	907	20,600
Midland	1,326	1,588	18,219
London & North-Western	2,058	2,158	15,800
	5,367	6,927	4)72,016
	Average of all		18,004

American.	*No. of Engines.*	*Miles operated.*	*Train-miles per engine.*
Pennsylvania...........	515	*1,071	32,627
New York Central......	602	†1,000	30,870
Michigan Central.......	219	804	30,812
Erie	468	956	26,900
	1,804	3,831	4)121,209
	Average of all...........		30,302
Indian.			
East Indian............	450	1,504	14,737
Great Indian Peninsular.	331	1,288	17,000
Madras	100	858	23,334
Bombay and Baroda....	64	417	19,149
	945	4,067	4)74,220
	Average of all..........		18,555

The above shows 12,298 more train miles per engine for American roads than for English, and 11,747 than for Indian roads. The following statement shows the average cost of locomotives on four of the English roads, and the average cost of American engines:

English.		*American.*	
Midland	£2,648	1st-class Passenger Engine (C)	£1,720
Great Eastern........	2,271	1st-class Goods Engine (D)............	1,800
Great Western.	1,767	1st-class Goods Engine, extra power (E)	2,300
London & N.-Western .	1,617		
	4)8,303		3)5,820
Per Engine........	£2,076	Per Engine.......	£1,940

Mr. Danvers' report does not show the cost of the English engines erected ready for service in India. I am confident that American engines will cost no more, if so much, as the freight from New York to Bombay, Madras, and Calcutta is nearly the same as from Liverpool, say 40s. per ton.

* On the Pennsylvania Railroad, including the double and third lines, the aggregate number of miles operated by the 515 engines was 2,881.

† On the New York Central the same was 2,433 by 602 engines.

I find, from the official reports of the colony of Victoria, that the American locomotives built for the Government Railways by the Rogers Locomotive Works, of Patterson, New Jersey, cost, erected in Melbourne, £2,132 each; whereas those built in England, and erected in Melbourne, cost from £2,352 to £3,032 each, and those built in the colony itself cost erected from £2,939 to £3,571 each. The American engines for the Colony of Victoria, and for the New Zealand Government railways, were ordered through Mr. W. W. Evans, Mem. Inst. C.E., who has an office in New York, at 66½ Pine street. They were built and shipped under his direction entirely. The best American narrow-gauge engines cost, delivered f. o. b. in New York, as follows:—

1st-Class Passenger (C).......	£1,500 per engine.
1st-Class Goods (D)..........	1,600 per engine.
1st-Class Goods, Extra (E)....	1,700 per engine.

Mr. A. Morris, Executive Commissioner (to the Colony of New South Wales) to the Philadelphia International Exhibition of 1876, reported to his Government that American engines of the very best quality could be laid down in Sidney for £2,000, or £1,000 less than for those contracted for in England. Mr. Allison D. Smith, the Locomotive Superintendent of the Government railways of New Zealand, wrote on the 29th of March, 1878, as follows, in reference to the American engines which Mr. Evans had sent out to that Government: "The engines, or 'Yankees,' as they are called here, are working splendidly; they have given great satisfaction. I have picked out our best men for them, and they are great favorites. When I let it be known that six more were coming, the drivers and firemen all commenced to vie with each other in trying who should be best man in order to get one. The engines, being new are somewhat stiff, but I can plainly see that they will be economical in stores, and light in repairs."

Now, if the best American engines can be laid down in India and in our colonies as cheap or cheaper than English engines, and that they will run easier and with greater steadiness, involve less expense in repairs and renewals, and do less damage to the permanent way, it is surely worth while for consulting engineers, directors, and agents to consider the economy their introduction must occasion.

At the same time I must say it would be better if they were

never ordered than to place them at the disposal of any prejudiced or narrow-minded superintendent, who would be sure to injure them and give them a bad name, as was done in South America. In the hands of an intelligent and liberal-minded superintendent, I am confident they will prove far more effective and economical than our Indian and colonial experience has hitherto found to be possible with English engines.

The two best and most reliable locomotive firms in the United States are the Rogers Locomotive and Machine Works and the Baldwin Works. Both have immense establishments, tools, and appliances for turning out with the greatest expedition a large number of engines, surpassing any similar establishment in this country. The former firm are noted for their care in packing their engines for export, so that their engines always arrive in excellent condition, and free from rust. Mr. W. S. Hudson, the superintendent of the works, is an Englishman by birth, and as a lad was brought up on the Stephenson's works at Newcastle. He is now recognized as the ablest locomotive builder in the United States, and he is as good a master of natural and mechanical sciences as can be found in America, although almost self-taught.

The Baldwin Works have a more extended reputation than the Rogers, for they have agents and traveling partners everywhere, and their engines are excellent; but it is admitted by all the best experts with whom I have come across that those engines which are built under Mr. Hudson's own eyes and which have his brains on them are superior to all others.

I am surprised to find how slow we are in this country, in India, and also in our colonies, in adopting the Westinghouse automatic brake, the Miller's coupling and buffer to passenger carriages, which entirely prevents telescoping in collision, and the cast-iron chilled wheel made of the Salisbury iron of Connecticut, all three of which railway appliances are now in general use in the United States. In my judgment no railway train can be *safely* worked in these days without the Westinghouse brake, and to pause in adopting it simply because of the possibilty of something better being discovered is no valid reason, while the lives of passengers and valuable property are in daily jeopardy. It should be remembered, on the principle that "the proof of the pudding is in the eating," that the Americans are the most experienced railway managers in the world, as they have upwards of 74,000 miles in daily opera-

tion, 3,000 miles of which are narrow gauge lines, and that on the majority of their roads these three railway appliances are adopted and have been in use for years. I believe if we adopted the use of the cast-iron chilled wheel we should effect an immense saving. These wheels have a life of 100,000 miles, and cost only £3.10s. as against £7 to £9, the cost of the English steel-tired wheel. The weight of a wheel for a passenger carriage is about 525 lbs. The metal is charcoal iron, having a tensile strength averaging 14 tons per square inch. When you compare the life and first cost of these wheels with those you have in use in this country, in India, and in the colonies, I think you must be struck with the financial importance of the result.

Another most useful and handy machine in general use in America, especially on the Western prairies, where fuel is scarce, is the Corcoran wind machine for pumping. I think it is the most perfect wind motor ever invented. It is used in connection with cedar tanks, holding from 50,000 to 150,000 gallons, for supplying the engines. The machines are entirely automatic. They set themselves to the wind, and turn their face from it when it blows too hard; they can be regulated to any strength of wind, and will work in the lightest zephyr.

The cedar tanks, if properly covered, last fifty years and upwards. By soaking the staves in silicate of soda, and then in chloride of calcium, they can be made to last for a very long period.

In India we have only about 7,000 miles of railway to a population of about 200,000,000. In the United States they have 77,470 miles to a population of 45,000,000. The railways in the United States have cost on the average for construction and equipment about £12,000 per mile, and some of the principal and best roads, like the New York Central, have cost only £9,000 per mile, and their narrow-gauge roads, 3 feet to 3½ feet gauge, £4,000 to £6,000 per mile. In this country we know that the cost has been £37,433 per mile, and in India £15,763; the East Indian cost £20,365, and the G. I. P. £18,000 per mile.

In the future construction of railways through villages and plains, where alluvial soil exists in which the common plough will operate, and where horses, mules, and bullocks, are available, an immense economy in cost of earthwork may be effected by the use of the American "Wauchope," and the "Sleessor" earth-

excavating and moving machines, and also with the Chicago self-revolving scraper, all of which are very largely employed in the United States. I have used them myself on very large works in California, and with labor at 12s. per diem, and horses on hire at 6s. to 8s per pair, I have moved earth into embankments at the rate of 1,000 cubic yards a day with the "Wauchope," and at the cost of under 1d. per cubic yard.

Many people are inclined to believe that labor is cheap in India, because they get into the way of comparing it with English and European labor; but in reality it is not cheap for India, when the limited wants and frugal fare and habits of the people are considered, as well as the vast amount of earthwork yet to be done in that country in railroads, canals, &c., and the very limited capital at the disposal of the Government.

Another great economy effected in railroad construction in America is in the adoption of the "Whipple" truss bridge. The English engineers of the railways in Canada have gone to the United States for their large-span iron bridges, because they have found that they could not get as good for the money elsewhere, notwithstanding that the American iron is charged 17½ per cent. duty in entering Canada. Messrs. Clarke, Reeves, & Co., of Philadelphia, have built and erected over three miles in length of their "Whipple" truss bridge on the Canadian Railways, besides nearly nine miles of similar bridges in the States and in South America. The iron they use is made from the ore found on their own premises, and this iron has always shown a much greater tensile strength than the best classes of English iron in the market, and may safely be taken at 30 tons per square inch for tension, whilst their patented Phœnix columns have been proved to have a resistance to compression which has never been obtained before.

The facility and rapidity with which these bridges are erected appears almost incredible to the English engineer, who is practised only in the English rivetted girder work. I have known spans of 150 feet erected in a single day of eight or nine hours. As a rule, the rivetted work takes just as many weeks to erect as the pin-connected work takes days. The advantage of the pin-connection, besides being the most scientific and proper, is that all the skilled work is done in the shops, and none on the scaffolding during erection, so that the work of erection goes on with a facility and rapidity utterly impossible on a rivetted structure.

The pin-connected work is also cheaper than the rivetted, because there is less metal in it. In proportioning the different parts, the strength of each part is increased in proportion to its nearness to its work, so that, in carrying out the principle of "Uniformity of strains," the American structure is of the strongest combined with the lightest, and thus there is no useless weight of iron to be paid for. They have been proved for years under the heaviest railway traffic, and found thoroughly safe and efficient. All the parts, being made by machinery, are of exact uniform dimensions in similar spans, and are therefore perfectly interchangeable. This greatly facilitates the erection and the rebuilding of these bridges.

I believe that these American bridges, of spans not under 150 feet, can be laid down and erected in India and in our colonies considerably cheaper than English bridges.

I have, &c.,

R. M. BRERETON.

Sir Julius Vogel, K. C. M. G., &c.

EXTRACT from a LETTER of Mr. W. W. EVANS to Mr. THOMAS HIGINBOTHAM, Engineer-in-Chief of the Victorian Railways, Australia, dated 3rd March, 1878.

Locomotives.

I note what you say about them, and that those I sent were doing good work. I was much pleased to find that you were running them on heavy work. I ought to have sent with them two sets of valves. I think we could arrange a set of valves for those engines that would save when working on heavy traffic another two pounds of fuel per train-mile.

You say there is a prevailing impression that the American engines will not last over five to seven years. I propose to give you a few figures on this matter to show to those interested in such things. I, some years since, saw in an English paper, the *Railway News*, a statement of the mileage of engines in England. I was so astonished at the small figures that I sent and got some data of English and American engines, so that I could compare them. This was in 1874. The figures were as follows for 1873, and give averages for the year of all the engines they had :—

English Railways.	*Miles.*
London and North Western..Train mileage..	15,415
Midland..................................	18,808
North Eastern............................	17,290
Great Western............................	18,320
	4)69,833
Average of all......................	17,458

American Railways.	*Miles.*
Boston and Albany.......Train mileage....	24,500
Erie.....................................	27,550
New York Central.........................	26,933
Pittsburg, Fort Wayne, and Chicago........	31,737
	4)110,720
Average of all......................	27,680

The above gives an average of 10,222 miles for the American engines more than for the English. This is decimally 58 per cent. greater duty, and it was done on inferior tracks, in a more severe climate, over steeper gradients and sharper curves, and with heavier loads. It must be admitted in making this statement that the English engines no doubt showed a greater average speed than the American, but, with this admitted, they should show greater average mileage in the year.

Let us look at some more average mileages in 1876. The Illinois Central Railway had 202 engines. They averaged 27,819 miles in the year. See *Engineering*, March or May, 1876. In 1875 the Central Pacific Railway had 203 engines; they ran 5,676,030. This gives an average of 27,960 miles. The report of the Missouri, Kansas and Pacific Railway for 1876 gives the engine mileage of that railway as averaging 37,811. *Engineering* for November gives mileage of that railway as averaging 37,811. *Engineering* for November 10th, 1871, pages 305 and 310, gives the average mileage of engines in England on twenty railways for six months as 9,168 miles; this for the year is 18,336. *Engineering* for May 11th, 1877, gives the average mileage of twenty-two railways in England in 1875 as 17,934. In McDonell's paper. No. 1469, on the repairs and renewals of locomotives, read before the Institute of Civil Engineers, January 16th, 1877, there are many statistics in relation to locomo-

tives worthy of close study. On page 68 he gives the half-year mileage of twenty railways in England to July 31st, 1876, the average being 881,207 for the year—this gives 17,625. Facing page 35 he gives a table of mileage of 176 engines on the Great Southern and Western Railway of Ireland, which shows an average mileage for ten years of only 13,926. On page 41 he makes out that these 176 engines would last 11.95 years, running 20,000 miles a year. On page 49 he says the average age of the Great Western engines was 6.1 years. On page 74 the President, in his closing remarks, says: "Many engines had been killed earlier than they ought to have been, because the traffic had increased faster than the engines to keep pace with it." He also says on page 75, referring to the North-Eastern, "That company had scarcely a spare engine. The engines were at work day and night." Now, if this was the case, that the engines were at work day and night, I cannot understand how they came to have such low average mileages in a year as 17,000 to 18,000, particularly as the loads are light, the roads good, and the speed high.

The report of the Pennsylvania Railway for 1874 shows the average of all their 786 engines, passengers and freight, to be for the year 26,263. One of these engines, No 133, on Middle Division, is put down in this report as having run in the year 83,820 miles, on passenger trains. They give the largest run of any engine on each division. Thinking this might be an error, I wrote to Mr. Ely, the Superintendent of Motive Power, to ask if he would confirm this tremendous run. He wrote me that this engine not only ran the 83,820 miles as reported on passenger trains in 1873, but ran 2,904 on freight trains. This makes 237½ miles a day for every day in the year, and is much the largest run I ever heard of. You may depend on it that engines that can perform such duty are not toys or flimsy things. Taking 17,500 miles as the general average of engines in England, this mileage shows that this engine, No. 133, did 5½ years work in one.

This same report shows that a freight engine, No. 215, on the same division, ran 48,012 miles in the year. The Pennsylvania Railway does not give the age of the engines or data to get it; but the Reading Railway does. They give No., class, weight, maker's name, date when first run, miles run in the last year, total miles run, and service employed on. I will give you a few figures from the company's report of 1875, giving data up

to the end of their official year, 30th November, 1874, when they had 403 engines:—

No.	Class.	Weight in Tons of 2240 lbs.	When first run.	Miles run in Year 1874.	Total to Date.
23	1st	26.9	July, 1852	24,780	410,733
44	1st	26.2	May, 1857	25,484	438,541
45	1st	23.8	June, 1857	27,428	422,222
49	1st	25.2	Aug., 1857	28,593	475,733
57	1st	25.2	June, 1859	35,407	426,071
58	1st	25.2	June, 1859	35,142	455,428

The above-named engines were all built by the Reading Railway Company, at their own shops; they were all passenger engines; they had been running from fifteen to twenty years, and you will see that each of them did a large service in 1874. Taking 17,500 miles as a fair yearly average, these engines had been doing the equivalent of twenty-three to twenty-six years. I do not give the above figures as averages in any way. I selected them as giving large runs for the last year, and large totals. Some of their engines have five pair of drivers coupled that can run without complaint around curve of 600 feet radius; we have five of such engines on the railways of the Consolidation Coal Company of Maryland, where I have a large interest, and was for years a director. They do us good service, haul immense loads cheaply, and are easy on the track. I sent a photograph of this class of engines to the institution of Civil Engineers. When Mr. H. Coneybeare, a member, was here, he told me the gentlemen of the Institution in Great George Street thought these engines were a "myth." I took him over to the Reading Railway, and showed him they were not a "myth." I placed him by the side of a curve—the sharpest there—600 feet radius, and told him to note that these engines run the curve without a squeak or groan.

You are right about the engines looking light, but they are not so in reality. They can and do do their work, and live to an old age. Don't fear their living only six to seven years. Much of the life of an engine depends on various circumstances, such as having a good driver, good water, fuel without much sulphur in it, a good track to run on, mild climate, repairs when required, not overloaded and the fires not urged to their utmost, moderate speed, &c., &c. All these things tell on an engine.

The ENGINEER in CHARGE, North Island, to the Hon. the MINISTER for PUBLIC WORKS.

Public Works Office, Wellington, 18th January, 1879.

Re comparative merits of American and English locomotives, as set forth in Mr. Brereton's letter, and forwarded by Agent-General.

This communication has been carefully read and considered, and I herewith forward a memorandum, prepared by Mr. Maxwell, which will be found to place the matter in a light very different from that imparted by Mr. Brereton's letter.

Further information on the whole subject will be obtained hereafter and laid before you, but I think sufficient grounds will be found in the accompanying memorandum to warrant the continuance of orders for locomotive engines being sent to England: not necessarily to the exclusion of orders for American engines, which, doubtless, will be found to answer well on certain lines and under certain conditions. In reference to the length of time which elapses after giving an order for engines in England before the receipt of the engines here, I may venture to offer an opinion, and to express it strongly, that sufficiently prompt action is not taken by the Home Consulting Engineer on receipt of an order, but that much time is needlessly lost. There is no possible reason why large English firms, with all necessary appliances, with which most of them are equipped, should not turn out locomotive engines as speedily as the American makers.

JOHN BLACKETT.

The Hon. the Minister for Public Works.

The DISTRICT ENGINEER (Unattached) to the ENGINEER in CHARGE, North Island.

Public Works Office, Wellington, 16th January, 1879.

Mr. Evans's and Mr. Brereton's letters contain but little information which conveys any practical intelligence to a professional man which would permit him to give a verdict on the respective merits of the engines. They contain some vague generalizations which are calculated to mislead an unprofessional man. The subject is taken up as though it were new and previously undiscussed: it has, however, formed a subject of minute examination by some of the best engineers in both countries for years past.

The data necessary to enable a professional man to judge and to compare would comprise—the gross weight of the locomotive in working order, the adhesion weight of same, diameter of cylinders, stroke of piston, diameter of driving-wheels, wheel-base and particulars, tank capacity, coal capacity, particulars of boilers, heating surface, &c., working pressure, the cost of engines, the cost of running them, the engine mileage, the data showing how the engine mileage is computed, the character of the gradients, curves, and gauge on which the various classes were required to work. Then any particulars as to the average performances would be of some service; but without such data no locomotive engineer would pretend to offer an opinion.

Amongst some of the general and vague statements in Mr. Brereton's letter to which exception may be taken are as follow: Speaking of America, he says they have "steeper gradients, sharper curves, more severe climate, heavier loads hauled, and less speed in running." He classes these as drawbacks in obtaining a large train-mileage; but that low speed is a drawback is a very questionable assertion.

As regards gradients and curves, English lines show every gradation from the Festiniog (1 ft. 11½ in. gauge), which has curves 1¾ chains radius, and the Monmouth and Blaenavon line, with 1 in 42 gradients and 6-chain curves, up to the first-class lines with no curves sharper than 30 chains, and seldom under 60 to 80, and gradients not steeper than 1 in 100.

Mr. Zerah Colburn, an American engineer of considerable eminence, and a most able writer on this subject, in a paper on American locomotives read before the Institution of Civil Engineers, London, in 1869, says, "What are now understood as steep or exceptionally steep gradients are rare in the States." No doubt since 1869 many lines with steeper grades have been constructed, but these particulars suffice to show the fallacy of the generalizations regarding curves and gradients; and, as regards loads, Mr. Brereton quotes no data available for comparison.

Again, Mr. Brereton says, "The English engine is a very heavy affair," &c., and quotes from a newspaper "The wheel-base is rigid; the whole engine is stiff," &c. There can only be one inference to be drawn from this by an unprofessional reader—viz., that all English-built engines are alike, and are

rigid, stiff, and undesirable, and that all American-built engines are the reverse.

It would be unnecessary to remark to a professional man that the English-built engines comprise machines of various types—there are light engines and heavy engines, with long rigid wheel-bases and with short and flexible wheel-bases—and that American-built engines show the same diversities.

The English-built engines vary from the Fairlie, with a rigid base of 5 ft., or a contractor's tank-engine with about the same, and the Adams or Bissel-Bogie fitted stock, up to the London and North-West goods engine, with a 15 ft. 6 in. base, and in weight from eight tons up to fifty tons. The American locomotives will exhibit similar divergencies, and, consequently, such a generalization as I have quoted is unreliable.

The American Bogie engines of the type we have in New Zealand, with small rigid wheel-base, are, as stated, well suited for bad roads and for sharp curves, but they do not present special advantages for working steep grades. That American engines are not always found most suitable, is practically illustrated by the case on the Iquique Railway, Peru, a line with long gradients of 1 in 25, where Mr. Evans's engine was found to be less successful and more costly to work than the English Fairlies, which are now exclusively used, the American engine being abandoned.

The statements to support the views that American are superior to English-built locomotives are as follow: 1. That the American obtain a larger train-mileage. 2. That the first cost of the American is lower.

Of the first statement I may say it is put forward without a single qualification; and the inference that generally the American engines are 50 per cent. superior to the English is quite erroneous.

There are many different ways of computing train and engine mileage, and with the same amount of running different computers would produce widely differing statements. To compare the train-mileage of two countries in so crude a manner is therefore manifestly erratic.

There are, besides the method of computing, other reasons why the Americans show a larger train-mileage. Mr. Brereton points out one—it is that Americans run continuously and so obtain a greater mileage; the English practice in running places the locomotive at a disadvantage as compared with the

American, but this has nothing to do with the efficiency of the machine.

Again, the English averages extend over a greater number of years and take in a large number of old engines. More recent averages give a much higher result. For instance, three years running of single Fairlies on the Great Southern Railway of Ireland showed 25,000 train miles as an average. The London and South-Western Railway, England, for the six years ending 1874, was working with an average of 25,000 train-miles.

In this colony the English-built engines were working from 25,000 to 30,000 miles a year. It is not, however, rational to make general comparisons without specific data.

In framing the form of statistical returns for locomotives in New Zealand, I consulted Mr. Conyers, and he determined the method of computing the train-mileage, and agreed on the other statistical statements, and the returns on this basis are now rendered to the Commissioners by the Managers, and they contain every information necessary. As there are two American engines, constructed under Mr. W. W. Evans's supervision, now running in the South under somewhat similar circumstances to the English-built, they may, *to some extent*, be compared, and Mr. Conyers could readily furnish the data for comparing working statistics : such data, however, must be, even then, received with great caution, because long average periods are necessary to eliminate accidental features, and the number of engines will largely affect the results.

As regards the statements made by Mr. Brereton about cost, I am not exaggerating when I state that the values of a cart-horse and a racer might as reasonably be taken to draw inferences from, as to the respective merits of the animals, as might his figures in the absence of data. I will compare the first cost of an American engine now working in Christchurch with an English engine also working in the district. They are alike in some respects, but not intended for the same service. They are both tender engines, and each have eight wheels, are about the same weight, and approximately the same cost each, and the adhesion weight and cylinder-power are in like proportion in each. The American has four-wheels coupled and two bogies ; it cost erected in New Zealand about £2,800. It has a tractive force for each effective pound of pressure of 60 lbs. The English engine has six wheels coupled, and one bogie ; it cost erected in New Zealand about £2,700. It has a tractive

force of 93 lbs. for each effective pound of pressure. The comparative cost of the two engines, based on their efficiency for traction, will be—for the American, £46 6s.; for the English, £29.

The English engine is much superior on lines with steep grades and moderate curves, and is much the cheaper. It would not, however, be suitable for the service for which the American is designed, which is a faster engine, nor would it work so satisfactorily on sharp curves. The comparison is not, therefore, worth much except to show how very fallacious are Mr. Brereton's general statements; and when you compare the cost of the American engine (£2,800) with the average cost given by Mr. Brereton (£1,500 to £1,700), it shows still more the necessity for requiring specific data for judging from. The cost of some of the types of engines working in New Zealand is as follows:—10-inch cylinder double Fairlie, £3,200; 14-inch cylinder Christchurch goods, £2,700; 12-inch cylinder American passenger, £2,800; 10½-inch cylinder six-wheel coupled, £1,500; 9½-inch cylinder four-wheel coupled, with bogie, £1,300; 8-inch cylinder four-wheel coupled, £1,000.

The Americans cannot compete with the English in cheapness, or in the class of work they turn out.

These remarks are not intended to depreciate the merits of Mr. Evans's engines, of which there are now eight working in Christchurch. Mr. Carruthers recommended the importation of two on trial, and Mr. Conyers was so far satisfied with them as to recommend obtaining six more. This is a sufficient evidence that those imported to New Zeland were found to answer the purposes for which they were required, and to show that their merits are appreciated. It is, however, desirable that unqualified statements of the universal efficiency and superiority of American-built locomotives should not be circulated without comment, as they are apt to mislead. The class of locomotives required on a line will always have to be determined by the features of the line, the kind of traffic, and the rate of speed demanded. J. P. Maxwell.

The Engineer-in-charge, North Island.

Copy of Memorandum sent out by Messrs. Hemans, Falkiner, and Tancred.

November 25th, 1878.

Gentlemen: As you have from time to time supplied locomo-

tives for the New Zealand railways, we beg to direct your attention to the following paragraph which appears in the report of the Commissioner of Railways, addressed to the Minister for Public Works, under date July 24th, 1878. With regard to the American engines the Locomotive Engineer reports:

"They have now proved themselves to be both good and economical, and for attention to detail in design and general excellence in workmanship they stand out first in our catalogue of locomotives. American engines I thoroughly believe to be more suited for our lines than anything we can get built in England."

Messrs. NEILSON and Co. to Messrs. HEMANS, FALKINER, and TANCRED.

Hyde Park Locomotive Works, Glasgow, 27th November, 1778.

Dear Sirs: We are in receipt of your esteemed letter of 25th instant.

We are neither prepared to admit nor deny the statement made regarding the merits of the American locomotives. We are, of course, quite ignorant of the design and details of the engines in question, and therefore cannot form an estimate of wherein they differ in these respects from the engines built by ourselves and others for the New Zealand railways.

The ordinary American type of engine, such as is in use in America, is, we have not the slightest doubt, better adapted for railways as now constructed than the engine used in this country. It is more flexible, and adapts itself better to the line than our excessively rigid engines. It has also the advantage of being less costly, though, we quite believe, equally efficient in its details, by reason of these being of simpler construction and frequently of cheaper materials.

We need not tell you that, although holding these views, it would be needless our attempting to persuade our locomotive superintendent to adopt even a modification of the American type, as you will be well aware of the vast amount of prejudice that would have to be overcome.

While admitting that the American type of locomotive may have some advantages over those of this country, we must be allowed to protest against the assumption that they can only be made in America. This is a great mistake. We have our-

selves been in competition with American firms for the supply of engines of the American type to an American railway, and secured the contract, notwithstanding that our cost for delivery on the rails was necessarily so much higher that that of our competitors.

We enclose photograph of this engine, No. 346.

Quite recently engines of our own design were accepted for a colonial railway in preference to American-made engines of American type; price having been an important consideration.

We enclose photograph No. 484 of engines recently constructed by us for South America, where American makers compete with us. You will observe that it is an engine of a modified American type.

We are prepared to make engines to any drawing and specification that may be submitted to us, and to enter into competition for the supply of the same with any American makers; and we undertake that our engines will give equal satisfaction, both as regards design of details and general excellence of workmanship, and will prove quite as economical as those made in America.

If you could, for our private information, give us a sight of the drawings and specification of the American-made engines on the New Zealand railways, we should esteem it a great favor.

We are, etc.,

NEILSON & CO.

Messrs. Hemans, Falkiner, and Tancred.

The VULCAN FOUNDRY COMPANY to Messrs. HEMANS, FALKINER and TANCRED.

Lancashire, 28th November, 1878.

Gentlemen: We beg to acknowledge receipt of, and to thank you for, the memorandum you have been good enough to send us in reference to American locomotives in use on the New Zealand railways.

We must confess that we are not sufficiently cosmopolitan in our ideas to learn without feelings of sorrow that we may, probably ere long, be driven from yet another field of operations which we might naturally almost call our own.

Without inquiring too closely into the causes which have made a report so antagonistic to the interests of English manufactures possible, we should much like to know whether our transatlantic competitors built these particular engines to

a specification and drawings supplied, or whether the design and carrying out of details was a matter left entirely to themselves.

We suppose the latter, in which case we submit the comparison between ourselves and the American builders is most unfair.

We are prepared to admit that the American type of engine —we allude particularly to the "bogie" principle, and more especially to the "Bissel" form of same—is certainly better adapted to the nature of the curves and permanent way usually prevailing in our colonies than the rigid wheel base of our English engines; but such is the absurd conservatism existing in this country that any departure from existing types would not be entertained, and we know that it is only within a comparatively recent period that any of our locomotive engineers would tolerate the "bogie" system on their lines of railway. If English builders are compelled to adhere to a particular type and specification of an engine, they surely cannot be held responsible for its performances or failures. So much for design.

In reference to "attention to details and general excellence in workmanship," we will couple these, and can only say that we have yet to learn that the palm has been wrested from out hands. On the contrary, we are still under the impression, from all we have heard, read, or seen, that English work is not only equal but superior to that turned out by American manufacturers.

As to first cost, permit us to remark, that American houses possess an immense advantage over us, from the simple fact of their being able to supply standard types, for which special appliances may economically be provided, whereas in this country every locomotive engineer is guided by and follows only his "own sweet will." This adhesion to a particular type also enables the producer to deliver engines at the shortest possible notice, which often is of paramount importance, and would frequently be the means of securing an order.

The American type of engine, specification remaining the same, could be built as substantial, accurate in workmanship, and, we believe, in quality, as cheaply in this country as in the United States of America. We are, etc.,

THE VULCAN FOUNDRY COMPANY (LIMITED),
(per Edward Bretteth Manager.)

Messrs. Hemans, Falkiner, and Tancred.

A LETTER BY W. W. EVANS,

BEING A COMMENTARY ON MR. MAXWELL'S CRITICISMS.

To the Honorable the AGENT-GENERAL for NEW ZEALAND,
London.

New, York, Febuary 14, 1880.

Sir:—I have the honor to lay before you a few comments on parts of a parliamentary document sent to me from New Zealand headed *American and English Locomotives.*

This Document contains a long and able letter by Mr. R. M. Brereton, late Engineer-in-Chief of the Great India Peninsula Railway, a letter written by myself to Mr. Higinbotham, Engineer-in-Chief of the Railways of Victoria, Australia, and not intended for publication; a criticism on the above letters by Mr. J. P. Maxwell, of New Zealand, and some opinions on engines by Messrs. Neilson & Co., of Glasgow, and the Vulcan Foundry Company of Lancashire. As the letter of Mr. Maxwell contains some errors of fact as well as opinion, I beg permission to offer, in as brief a manner as possible, a few comments on his criticisms.

To combat ignorance and prejudice is a very thankless and unsatisfactory duty to perform, as it appears to be an inherent principle in the brain of man "to try to believe what he wishes to be true." Mr. Maxwell undertook a duty that he was sadly incompetent to perform, simply because he had never seen an American locomotive and knew nothing about them, and being a Civil Engineer he could not be expected to know much about locomotives of any kind. He has, however, written a long

letter, stated some things that are not based on facts, and jotted down a considerable amount of special pleading and fallacious argument. Most American Civil Engineers would "come to grief" if they attempted to write on English locomotives, for the simple reason that they know nothing about them. Mr. Brereton has written a long and very able letter in connection with railway economy, and deserves credit instead of severe criticism. He has given piles of facts and valuable data, and expressed opinions that any unprejudiced mind was sure to arrive at with such evidence as he had. He was well able to judge correctly on the subject he wrote on, as he had many years of experience in connection with railways, first in England, then in India as Chief on one of the most important lines of railway in the world, then for some years in the United States, and now in England again. Surely a man with such experience should carry some weight in his train when he expresses an opinion, and particularly when it is understood that he is an educated English gentleman, living in England and not in any way connected with any American enterprise or industry. He simply wished, without fee or reward, to give to railway progress a few facts from his storehouse of experience and knowledge, the same as Fox, McDonnell, Colburn and others had done before him, in the elaborate and clever papers they wrote and read before the Institution of Civil Engineers of England, and for which they were so highly complimented.

I have no knowledge of how my letter to Mr. Higinbotham came to get into print. It was a hurriedly written private letter, written to prove one single point, namely, that American engines were not short-lived affairs, and if that letter is not a full and convincing proof of that fact then I submit that figures are deceptive, and that there is no use in referring to them in discussion or argument.

It was asserted by an English writer on political economy, that any man who could make two spears of grass grow where only one had grown before, was doing a benefit to all mankind. In the railway world it has been conceded that the true measure of railway economy is the cost of carrying a ton a mile, and that any one who can, by any device or system, produce this result, is adding something to the progress of the age in which he lives. The whole matter of railway progress and economy is wrapped up in this one item of cost of carrying a ton of goods a mile, and a passenger a mile. It has often been

asserted by "croakers," afflicted with weak-thinking organs, that the superiority of the English railway system is proved by the fact that the ratio of expenses to receipts in England is less than 50 per cent., while in America it is more than 50 per cent. Any railway investigator can readily see that in a country where labor and materials are high priced, and where the railway tariff of charges is low as in America, the ratio of expenses to receipts must be higher than in England, where labor and materials were low priced and the tariff of charges high.

We claim in America that we have solved the problem of cost of carrying on railways a ton of goods a mile more finely and obtained more satisfactory results than has ever been obtained in any other country in the world. I will give the figures of cost of carrying a ton a mile for a series of years on the Pennsylvania Railway, and if any one can match them with better figures on any railway in England or Europe I will be delighted to see them :

PENNSYLVANIA RAILWAY. GOODS TRAFFIC COST IN CENTS PER TON PER MILE.

Years,.. 1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878
Cost, ... 1.82	1.54	1.25	1.20	1.00	0.87	0.886	0.857	0.719	0.616	0.582	0.552	0.483

It must be recollected that the through traffic of this railway is all carried over the Allegheny Mountains, on gradients of 1 in 55, and many curves of less than 1,000 ft. radius.

The fallacy of the argument in reference to the ratio of expenses to receipts proving anything, is shown when I state the facts that, in 1859, the expenses of the Grand Trunk Railway of Canada were 2 per cent. more than the entire receipts, and that in the same year the ratio of expenses to receipts on the Panama Railway were only 23 per cent., and that the same for 22 years, from the year it was finished to the last year I got the statistics, 1873, the average was $32\frac{4}{10}$ per cent., and this, too, with enormous expenses for labor and materials ; but the tariff of charges was still more enormous.

Mr. Maxwell commences his letter by saying that there is but little information in Mr. Brereton's or Mr. Evans' letters that conveys any practical intelligence to a professional man, that they contain vague generalizations that are calculated to mislead an unprofessional man, and that the subject is taken up as if it was new. I submit that papers that are full of facts and few

of opinions are of service to all professional men, and cannot mislead any unprofessional man, who is a reasoning creature and has a brain above that of a "non-compos."

Mr. Maxwell complains that we do not give all the data of each engine, train and road. Such data would swell an ordinary letter to the size of a book. As Mr. Maxwell calls for some more explicit data, I will give some in another part of this letter, as I am desirous to give the truth, simple and full.

Mr. Robert Stephenson, once said to me at his own table in London, when I was offering some theory as a point in discussion, "Don't give us theory, give us facts; we have got past the age of theory." I admitted the strength of his argument, and have vividly recollected his bringing me up with a "round-turn" ever since. I will give Mr. Maxwell some facts to ponder over, but first let me correct some of his mistakes that are calculated to mislead the *professional man*, as well as the unprofessional man.

Mr. Maxwell says that the American engines cost £2,800, each. These engines cost on board ship, with tender, $8,500 each; equal to £1,717. With insurance, freight, commissions, and a liberal allowance for cost of landing and erecting in New Zealand added, I make these engines to cost £1,998 each. I sold the bills on London to pay for them, and got one pound sterling for each $4.94½. I also engaged the freight, so I am giving facts that are within my knowledge. There is a very wide difference between £2,800 and £1,998. How Mr. Maxwell came to make this big error, I leave to him to explan; but having made such an error, I would like to ask if there is not a possibility of his having made an error in the other direction, when he put down the engine he used, in his comparison, as costing *about* £2,700. I wonder what limit in sterling figures Mr. Maxwell gives to the word "about." It appears to be about £802, or say 40 per cent. of the whole in the case of the American Engines. Mr. Maxwell makes reference to an American Engine on the Iquique Railway, in Peru, and calls it the "Evans Engine;" saying it was too costly to work, and that the road was worked by Fairlie Engines. I beg to say in answer, that I never had anything to do with the engine he calls the "Evans Engine." I did not design, order, inspect, or receive it. I would here add that, in that particular case, it mattered not if the engine was good or poor, it was doomed before it left here. Mr. Fairlie had won the affections of the

"Brothers Montero," the owners of the Iquique Railway, and by some "hocus-pocus" had made them believe that the engine he called his, was something wonderful and destined to regenerate the railway world. The Monteros were "innocents," and allowed their money-bags to flow freely into the pockets of Fairlie. Their faith was supreme, but their money-bags had a bottom. Fairlie put his faithful Henchman, a Mr. Clemenson, on the road as locomotive superintendent, and from that day until the Monteros were nearly ruined and had to transfer their interests to an English Company, there was nothing believed in, "cracked-up," or allowed on that railway but the so-called "Fairlie Engine." Before Mr. Fairlie and his man Clemenson were known on that railway, the Monteros, thinking that one railway was the same as any other railway, and an engine an engine—the same as one goose is like another goose—bought, as they would barrows or bars, two ready-made locomotives of Stephenson & Co. Finding they could not run their sharp curves, as they were useless, they then bought two "Mogul Engines" I had built for mountain railways in Peru. For one whole year, and up to the advent of Fairlie & Clemenson, these two engines did the entire work of that railway, and almost without repairs, for they had no shops or tools. Mr. Clemenson soon remedied this state of affairs. There was not much time lost in burning the flues of these engines, and then they were run out by the sea-side to allow the spray of salt-water to finish the job. I must do Mr. Clemenson the justice to say that before he was kindly relieved of all authority on that railway, he had not only ruined all the American Engines but all the so-called Fairlie Engines also. A merchant in Lima, said the Fairlie Engines were the best he ever heard of, because they ruined the rails, they ruined themselves, and the more they got the more they wanted, and the more they ordered the more his commissions were.

Mr. Maxwell is in error in saying that the Iquique Railway is worked by Fairlie Engines. When that railway passed into the hands of some English merchants, there was hardly a Fairlie Engine on the road fit to run. The new company ordered a new set of engines of another type.

An eminent German railway manager says he has no engines on his lines that cost as little for repairs as the Fairlies, for he takes good care to never use them. When I found that there was such a hue and cry set up against the American engines on

the Iquique Railway in Peru, and such a blast of "music in the air" about the wonderful performance of the Fairlie engines on that Railway, I made an offer to Mr. Fairlie, through the editor of *Engineering*, that I would give him the price of a Fairlie engine if he could produce authentic data that any one of his engines on that road ever did, on any single occasion, as much duty in proportion to weight on driving-wheels, as the American engines had done, as a regular duty on that railway every day for a year. This offer was never accepted.

In 1870 Mr. Fairlie had some experimental trials of his engines in England in the presence of some foreign Counts and other noble railway experts. They declared the results to be wonderful, and were more than anxious to sign the strongest certificate that could be drawn. The data of these trials was sent to me. Wishing to see how it compared as to duty performed at two government trials (one in Peru and one in Chili, South America) with engines under my direction (the trials being under the eyes and certified to by clever and experienced English engineers). I reduced the data of all down to one common basis of comparison, namely, foot-pounds of work done per hour per ton of weight on driving wheels, in moving train alone exclusive of engine. The results were as follows:

Fairlie engine "Little Wonder," Festiniog Railway gauge, 1 ft. 11½ ins. equal to 9,024,739 ft. lbs.

Fairlie engine "Progress," Mid-Wales Railway gauge, 4 ft. 8½ ins. equal to 9,272,339 ft. lbs.

Rogers American engine "San Bernardo," Southern Railway of Chili gauge, 5 ft. 6 ins. equal to 41,587,020 ft. lbs.

Rogers American engine "Conquistador" Arequipa Railway of Peru gauge, 4 ft. 8½ ins equal to 25,377,544 ft. lbs.

A full table of these comparisons was published in *Engineering*, Nov. 11th, 1870.

I will send you a copy of these comparisons and also a pamphlet in reference to this much-lauded Fairlie engine. Mr. Fairlie has never been very desirous to put his engines on any railway, unless he could "saddle" his Locomotive Superintendent also on the railway. Mr. Meiggs, the railway contractor of Peru, gave Mr. Fairlie an order for one of his engines, after much solicitation, merely to test it. Mr. Fairlie wished Mr. Meiggs to build his Trans-Andean railways with "breathing places" for his engines. Our engines have now worked those railways for years without lung-complaints, these railways hav-

ing gradients for many miles of 1 in 25, and sharp curves for nearly the entire distance up to the summits. One railway has over 70 miles that is over 14,000 feet above the sea level. Mr. Fairlie, in writing to Mr. Meiggs, says: "There is no engine of the ordinary type built in England of the description you give, as far as I can understand it, capable of doing anything like the duty you report having done—namely, 135 tons exclusive of engine, over a grade of 1 in 25, at a speed of 11¾ miles an hour. It would puzzle *even* a Fairlie engine to do such a duty. There must be some peculiarity in the climate or the gradient, or in *something or other*, which enables you to get such enormous duty out of your engines compared with what we can get here."*

Mr. Fairlie had *carte blanche* to build one of his engines and send it to Mr. Meiggs in Peru, but he never did it; there was *something or other* in the way. Mr. Maxwell says that the Fairlie engines on the Great Southern Railway of Ireland showed an average of 25,000 miles a year for three years. Now, as I am sure that this is what a Fairlie engine never did, I am led to believe that this is another error of figures in Mr. Maxwell's letter; and particularly as the Fairlie engines on the Mexican Railway, under the direction of one of Mr. Fairlie's own men, showed no such mileage. In 1874, the manager of that railway made out a statement in detail of the performances of the Fairlie and Baldwin engines, running from Vera Cruz to Boca-del-Monte. This table can be seen in full in the Report of Augustus Morris (Commissioner to the Centennial) to the Government of New South Wales. This table reduced gives the following figures:

Fairlie engines, miles per annum	14,371
Baldwin " " " "	28,673

Fairlie engines, running and repair expenses per mile	79.32c.
Baldwin " " " " " "	37.66c.

The above is for the only two Baldwin engines on that railway, and for the six best and newest of the seventeen Fairlie engines they had in December, 1874.

Mr. Maxwell says that the average mileage of the engines of the London and Southwestern Railway is 25,000 miles.

*The engines referred to had three pair drivers coupled. Weight on coupled wheels, 25.9 tons; diameter of wheels, 49 inches; cylinders, 18″×24.″

Now, although this railway does give the largest average of any railway in England, I cannot find a single year in which it gives as high as 25,000; but I do find this very railway figuring in the list of the twenty railways in England, giving an average of 18,336 miles. Again, in the list of twenty-two railways in England, giving an average of 17,934; and again, in the list of twenty engines, given by McDonnell, as averaging 17,625, all, as mentioned in my letter to Mr. Higinbotham. I would ask Mr. Maxwell if he thinks it fair, in a discussion of this kind, to pick out the railway that gives the largest average and parade its figures as a set-off to the averages of twenty railways.

Mr. Maxwell says that Mr. Brereton and Mr. Evans claim a larger mileage for American engines than is shown by English engines, without a single qualification. This is a singular assertion; we give the mileage as printed in English papers, which I took the trouble to confirm by official figures, and then we state that this mileage is made in America on roads subjected to more severe climate, gradients, curves, tracks and loads; if that is not qualifying the mileage statements, then I am at a loss to know what kind of qualification Mr. Maxwell desires.

Some twenty years ago, the *Engineer* published a statement of an engine performance in the United States, and then commented on it is follows: "The above engine performance, together with other similar data published in former issues of this paper, shows that from 20 to 25 per cent. greater duty is obtained from the locomotive in America than we can get here, and that, too, over what we know to be notoriously inferior tracks to ours. What can be the reason?" The editor of *Engineering* once wrote to me in the same strain, and asked me to write him on the subject and explain the causes.

Mr. Maxwell says, there are many ways of computing train-mileage. This is news to me. It must be a most objectionable record that has entered on it more or less miles than the engine actually run and hauled a train.

Mr. Maxwell says, it is questionable if low speed is a drawback in obtaining a larger train-mileage. This is another singular assertion. Surely he cannot mean that a goods engine, running 10 miles an hour, makes as great a mileage as a passenger engine that runs 40 miles an hour.

Mr. Maxwell alludes to Mr. Brereton's remark, that some engine economy may be obtained by running with two crews

to an engine, and infers from this that the greater average train-mileage of American engines is obtained in this way. I would state that this matter of double crews on engines is of very recent date, and is now practiced only on some trunk-lines for their heavy goods trains. The mileage made by American engines, and referred to in Mr. Brereton's and my letters, was not, in any case, made by engines having two crews.

The practical inference to be drawn by *professional* thinkers, when told that one system of railway equipment results in engines making an average of 15,000 miles a year, with loads of 200 tons, while another system, on similar lines, or more difficult, with equal loads, gives an average of 30,000 miles a year, is that the road with the 30,000 mile engine can whip out the other in the ratio of 2 to 1.

When I got an official report of the workings of the Fairlie engines on the Mexican Railway, and laid it before the Baldwin Locomotive Works Co., they said, with such data the proof is clear that we could, with nine of our Consolidation Engines on that railway, do all the work done by the seventeen Fairlie engines. Here comes in a point that is easily understood by the *unprofessional* mind. The nine Baldwin engines would cost in Mexico £26,000, while the seventeen Fairlies would cost £66,000, to say nothing of their greater cost for repairs, fuel, and destruction of track.

Mr. Maxwell says that this engine subject is taken up as if it was new and not before discussed. I beg to differ with the gentleman. It is well known to every railway engineer and investigator as an old subject, written on and discussed in various ways during the past forty years by some of the best and most lucid thinking and writing engineers of England. In 1843 John Weale published a book entitled "Ensamples of Railway Making," in which he draws a comparison between the cost of an American railway and an English railway, showing that while one cost £3,600 per mile the other cost £30,000 per mile. Mr. David Stephenson wrote a book called "Civil Engineering in North America," in 1838, and jotted down many interesting and instructive things. Mr. Isaac, Mr. Pasavant, Capt. Douglas Galton, R. E., Sir Charles Hartley, Mr. Neilson, Sir H. W. Tyler, and a number of other clever English engineers, have written most instructive papers on the railway system of America, and pointed out in forcible terms the merits of many things and ways as practiced here to their professional

brethren in England and urged their adoption; but they may as well have saved their pens, paper and patience, for their recommendations were as so much water poured on the sand. I intend to refer again to what some of these gentlemen said, thought and urged, but the soil on which they sowed their seed of belief and faith never produced any good fruit. Some twenty-seven years since I undertook to sow some American locomotive seed of this kind in England, but was promptly met with the assertion that we in America were all wrong and they were all right. If that was really so, why did they in Canada alter all their first English locomotives to American patterns, and then order a vast number more from the United States, paying a large duty on every one they received, and have continued their orders ever since. Why have other English colonies, Victoria, New South Wales, Queensland, South Australia, New Zealand, &c., sent to America for locomotives. Surely no Englishman in his senses would send to America for engines unless he had some pretty positive proof that he was going to get something superior in utility and economy to what he could get at home. I have never heard of any American manufacturer soliciting their orders. I have received and executed some of them, but I have never solicited them or expected them. I felt that there was no use in any American builder asking for orders, as they stood no chance of getting any. This was the case when a Canadian company asked for proposals for the Great International Bridge over the Niagara River. No American firm proposed. Finding there was no American proposal put in, the Canadians sent to Clarke, Reeves & Co., asking for a proposal. They put in one and got the work, not through any favor but because their bid was much the lowest. This bridge is a master-piece of engineering. At the time it was built it had in it the largest "Draw," (360 feet) ever put in a bridge. It stood all the severest tests, some of them under the eyes of Capt. Sir Henry W. Tyler, R. E. (It has carried a very heavy traffic for years.) Since then this firm of bridge builders have built all the long span bridges for all the railways in Canada, simply because they can do the work cheaper than others and pay a heavy duty besides.

Mr. Maxwell draws a comparison between two engines showing cost and tractive power. (I have shown that he makes a huge error in quoting cost.) He says the tractive force of American to English, of the two he compares, is as 60 to 93.

This is the calculated or theoretical force, but what is the relative powers of these two engines when at work? Which can utilize the greatest percentage of its power—which consumes the largest percentage in frictions—which can traverse the curves the easiest—which is the steadiest engine in running, which is easiest on the track—which requires the least repairs? All these are elements that the practical *professional man* will ask for. I cannot give them, but Mr. Maxwell being on the spot could and should have got and given all this data. It would, if favorable, have strengthened his argument, and it would, if unfavorable, as it was very likely to be, have knocked his argument all to " flinders." As I have not the New Zealand data of work, &c., actually done, I beg to mention some data of engine trials on a Government railway built under my direction in Chili, South America, in 1859. This railway, running from Santiago, the capital, to the south, had easy gradients and curves. Two engines were ordered from England and two from the United States, one goods and one passenger, from each country, with the understanding that they were to compete with each other. Before the trials took place, the Minister asked Mr. Bailes, the English engineer of the Valparaiso railway, to calculate from dimensions and weights the theoretical powers of these engines; that is, what they ought to do.

Mr. Bailes was the cleverest mechanical engineer that had ever been on the west coast; he made a correct and accurate calculation of the powers of each engine and compared them relatively. He showed that the English engines had theoretically the advantage in cylinder, tractive power, and in power due to adhesion of over 12 per cent. He shows the relative heating surfaces, and then winds up his report to the Government with the following passage :

"Thus we see that in addition to the superiority of tractive power of cylinders, and the tractive adhesion to the rails possessed by the English engines, their ability to sustain that power by the generation of steam exceeds by about 50 per cent. that of the American engines."

Now, having got through with the theoretical part, let us look at the practical part, the dimensions and the work done ; the part the *professional man* would be likely to ponder over :

Goods Engines			Passenger Engines.	
English by Hawthorne.	*American by Rogers.*		*English by Hawthorne.*	*American by Rogers.*
28 60	28.11	Weight in gross Tons......................	27.61	27.78
64081.	39160.	" on Driving Wheels in pounds........	46122.	39576.
6	4	Number of Driving Wheels.................	4	4
54	54	Diameter of " " in inches.........	62	66
16½ x 24	16 x 24	Dimensions of Cylinders " "	15 x 22	14 x 24
1188	912	Fire Surfaces............................	1204	783
586v335	587	Gross Tonnage (Cars v. Loads)..............	288	291
35 v	35	Number of 8-wheeled Cars in Train..........	15	15
88. m's.	41. m's.	Time to Summit 11⅔ miles	37½	26½
$20,001	$19,249	Cost of Engines erected in Santiago..........	$19,881	$19,129
$ 7,247	$ 2,701	Cost of Extras in Santiago.............	$ 6,782	$ 2,801
		Maximum Gradient 1 in 168		
		Minimum Radius of Curves in feet, 6562......		
		Limit of Steam Pressure agreed upon, 115 lbs.		
		All had Copper Fire Boxes and Brass Flues.		
		Cost of carrying each of these Engines over the mountains from Valparaiso to Santiago, over common road, was about $5,000.		

The English goods engine having failed to carry the *35 cars* with 586 tons beyond the 3d mile, was backed to station and tried with 130 pounds; failed a second time; was backed to station and tried with *20 cars* having 335 tons; got stalled twice and got to the summit in 88 minutes.

The cars were all long, eight-wheeled, and each loaded with 10 tons of railway bar iron. The four days of trial were fair with light winds, the rails dry and in good condition. Mr. Bailes, the mechanical engineer before-named, was on the footboard of each engine during the trials. The officers of the road, Secretary, Locomotive Superintendent, Station Master and Foreman were all Englishmen. The only Americans were the two that drove the two American engines, and they had English firemen. I must in justice say that the two English engines were about as badly designed, as badly balanced, and as stiff and clumsy affairs as I ever saw. They were what "Zerah Colburn" graphically called four and six-legged beasts.

I will send to New Zealand a detailed account of these trials so that Mr. Maxwell and other *professional men* may have something to judge by. The *Engineer*, in referring to these trials and giving much of the data, went into a labored argument to prove that the duty recorded as being done by the American goods engine must be false, as no engine of its dimensions had

ever, or could ever, perform such duty. I need only say, in referring to this, that Mr. Bailes was there with his eyes open, and that his notes agreed with mine exactly.

It may be interesting to some *professional minds* to know that in the trials of passenger engines, with trains behind them of *five times* the average weight of express trains of the London & North-Western Railway (See Ed. Wood's Private Reports), the American engine run some of the miles in 75 seconds, while the quickest mile of its competitor was 105 seconds.

Mr. Maxwell refers to Mr. Zerah Colburn as "an American Engineer of *considerable eminence, and a most able writer,*" and quoted from his Paper, No 1230, on American Locomotives, read before the Institution of Civil Engineers, to show that steep gradients in the "States" were rare.

If Mr. Maxwell had looked down the page from which he got his quotation he would have seen that Mr. Colburn says, the engineers in the "States" were the first to adopt long inclines of 1 in 45 and 1 in 90, and then goes on to give instances of engines working on gradients of 1 in 28.7, 1 in 16.5, 1 in 10, 1 in 18, 1 in 27, and 1 in 14, as far back as 1836. Surely, these might be called exceptionally steep gradients, but, after all, what has steep gradients to do with the designs or peculiarities of an engine? Why nothing, except where steep gradients are found, there also are found sharp curves; they are the "stumbling blocks" in the way of the locomotive engineer; they are the features that have called for so many devices and ingenious inventions, known and used by the engine builders of the "States," and it is because we have so many sharp curves that these inventions spring into existence here more than in any other country.

I supposed that everybody knew that steep gradients and sharp curves were very common railway features on all the mountain railways in the States, gradients of 1 in 40 and 1 in 50, and curves of 400 and 500 feet radius are to be found all over the States, and I have this very afternoon ridden over curves of 90 feet radius in the elevated steam railways of this city.

This Mr. Colburn was the editor of *Engineering*, and was considered in England the cleverest writer on mechanical matters of his day. When he was asked to write the paper above alluded to, he asked me to give him some data. I wrote him a long document, and gave him piles of data, but he did not

introduce it in his paper. He contented himself with saying that "the difference between American and English engines was more a matter of costume and toilette than of vital principles of construction." No man living knew better than Mr. Colburn that the main differences were far from being merely a matter of toilette. I had told him that he would not dare to put in his paper the data I gave him, as his "bread and butter" were at that time dependent on his keeping on good terms with all his English patrons.

Let us look through this paper of Mr. Colburn's and see if we can find anything worthy of reflection by a *professional man.*

Mr. Colburn says he was employed by the General Manager of the Erie Railway to run an experimental train over the entire line of that railway (a distance of 900 miles, going and returning), to determine the relative engine power required on each division; this was in 1855. I hope Mr. Maxwell will not consider this so far back in the "dark ages" of railway work as to be of no use to a *professional man.*

The record, as Mr. Colburn gives it, is as follows: The engine had four coupled wheels of five feet diameter and a bogie. Weight in working time, 29.50 tons; 17.90 tons on driving wheels; outside cylinders, 17 × 24 inches; valves set to blow off at 130 pounds; fire surfaces, 10,38 square feet; the tender loaded weighed 18.50 tons. The train consisted of 100 American eight-wheeled wagons loaded with deals; weight of each wagon loaded, 15.40 tons; weight of total train, 1,572 tons; each wagon was on two bogies, having four cast chilled wheels of 30 inches diameter in each bogie; journals of axles inside, 3.88 inches diameter and 8 inches long, running in oil-tight boxes.

This train was a few feet more than half a mile long. It was run on a gradient of 1 in 880, for 4 miles at a speed of 5 miles an hour, a stop being made in the gradient and the train started again with no aid from momentum. This same train was run for 5 miles on a dead level over curves of 957 feet radius at 9.70 miles an hour. The train being reduced to 30 eight-wheeled wagons, 514 tons in all, mounted a gradient of 1 in 117.50, at a speed of 10.25 miles an hour. Allowing for resistances due to gravity and also to concussions and frictions of engine and train, the coefficient of adhesion must have been one-third of the weight on driving-wheels. These results were obtained under the disadvantages of 6 feet gauge, small wheels

and large inside journals. Now if Mr. Maxwell will produce equal results in proportion to weight on driving wheels as the foregoing, made by any English or European engine he ever saw or heard of, at that time or any time since, I pledge myself to give 100 guineas to any charity he may name. Mr. Colburn says in his paper that wrought-iron wheels, at first exclusively used on the Grand Trunk Railway in Canada, have been wholly abandoned and cast-iron substituted; that they are much cheaper, more durable and equally safe, and that the safety and economy of cast-chilled wheels entitle them to the best consideration of English engineers. Again he says that Sir Edward Watkin, when in Canada as Controller of the Grand Trunk Railway, in the winter of 1861 and 1862, had all the six-wheeled tenders changed to double bogies, and to this change was attributed a great diminution in the breakage of rails during that unusually severe period; and yet in the face of such evidence and piles more of the same kind that can be produced, the Messrs, Neilson & Co., the most liberal, clever and progressive engine builders in the United Kingdom, after having said in their letter to Messrs. Hemans, Falkiner & Tancred that the American type of engine is better adapted for railways, as now constructed, than the engine used in England, goes on to tell us that it is needless for them to attempt to persuade their locomotive superintendent to adopt *even* a modification of the American type, as there would be a vast amount of prejudice to overcome. This is the most open but damaging confession that I have heard of yet. I had heard of the tyranny of the men in the shops (for a short time since the men in one of the largest shops in England refused to let a "Quartering Machine"—an American tool for the cheapening and doing work more quickly and accurately—come in the shops) but I had never heard before of a clever firm of leading engineers bowing down meekly to the imperial edicts of their Superintendent.

Sticking to Routine, sticking to old and antiquated ways of doing things, while a good portion of the world are enjoying the economy and beneficial results of improvements is more than I can understand. Using crank-axles and inside connections, keying wheels on axles, using grease boxes instead of oil-tight boxes, putting a heavy cone on the "Tread" of wheels, using double-headed rails in cast-iron chairs, and a lot more of absurdities, which have been proved to be errors and discarded by Americans long years ago, looks as if the railway engineers

in England were satisfied with what they had, and content to rest on their laurels for ever and ever more in a Chinese-like conservatism. In 1852 Mr. McConnell had a set of 6 American oil-tight axle-boxes tried on tender of engine No. 182 of the L. & N. W. Railway. A set of English grease boxes were tried at the same time on a similar tender. The engines were put to do the most trying work—running express trains at the highest speed, and ballasting. And after running 6,000 miles in four months they were examined. No oil had been added to the American boxes since the first day. The report (see proceedings of Institution of Mechanical Engineers at Birmingham, October 27, 1852) says: The journals and brakes of the tender No. 182 are, at the end of four months, as perfect as when new. There was enough oil in the boxes to run 3,000 to 4,000 miles more. A great advantage is found that the great wear, endways, does not take place on the brasses as in the ordinary boxes, using grease or tallow. The difference in saving of castings by the use of the American boxes is 176 pounds in a set of six. The American boxes cost for oil, waste and leather 1½ pence a day, while the other set cost 9 pence a day, or a saving of 7½ pence a day on a set of 6 boxes. This is all independent of saving in friction, labor in constant attendance on grease boxes, delays at stations occasioned by hot journals, &c., &c., and yet to this day, after these boxes were tried and vouched for by such a man as Mr. McConnell, they have never been adopted in England. Comment on this and similar matters in railway economy is not necessary. Such action is to me abominable, and it is a shame that railway interests should be sacrificed merely through a prejudice against the adoption of anything that was called American, even when it was really not American in its origin, as in the case of the bogie, for this swiveling truck took its name from a two-wheeled vehicle used in the streets of Newcastle. And Mr. Robert Stephenson told me that he proposed that device of the bogie to Mr. Robert L. Stevens when he was building the Camden and Amboy Railway, in 1830, as a proper means for traversing curves. A gentleman in London told me, not a great while since, that they had tried, on the Metropolitan Railway, every manner of device to facilitate running their long cars around the curves, so as to get rid of using the bogie, simply because it was known as the American system. Here is prejudice for you—clean, clear and unadulterated; unmitigated and unfathomable.

It has been maintained many times in England that great speed cannot be had with the bogie without great danger of accident, and yet these very obstructors on the track of railway economy must be most abominably ignorant, if they have never seen or heard of great speed having been run many times on roads in the United States, Canada and Russia, with trains using bogies, and over tracks where the four-wheeled English cars would be sure to leave the road. Now if the bogie carriages can be run with safety and certainty over our so-called miserable tracks, is there any mechanical or scientific reason why they cannot be run with the same safety, certainty and economy over the much lauded perfect tracks of all England? The fast train that was run from New York to San Francisco in June, 1876, presented some features that were worthy of notice by the *professional man.* This train was made up of three long, heavy cars, each resting on two bogies, having cast-chilled wheels. The same cars were run through the *whole distance* of 3,317 miles, the time being 83 hours, 27 minutes, including stops. This is very close to forty miles an hour, and has never been approached by any other railway run ever made. The run from New York to Pittsburgh was made (in the night chiefly) for the whole distance of 439½ miles *without a stop*, and at an average speed of 43½ miles an hour. In this distance the train passed over the Alleghany Mountains, attaining an elevation of 2,154 feet above tide, over a tortuous track having many sharp curves under 1,000 feet radius, and gradients up the mountain side of 1 in 55. This division was run at a speed of 42 miles an hour. The engine, No 573, that run this route was one of the ordinary engines of the Pennsylvania Railway. It had four coupled wheels of sixty inches diameter, with cylinders of 17″x24″, total weight 33.17 tons.

On some of the level lands east and west of the Mississippi River this train was run at a speed of 65 miles an hour. Arriving on the Central Pacific Railway this train was run the whole length of that Road, 881 miles, by one engine, No. 149, built in 1866, cylinders 16″x24″, driving wheels 60 in. diameter; running time 21 hours, 30 minutes—41 miles an hour. In this run the train had to pass over the "Sierra-Nevada" Mountains, the summit tunnel of which is 7,042 ft. above the sea, the route up the side of the mountain being one continued series of sharp curves of 600 ft. radius, and steep gradients of 1 in 45. There are on this railway 1,150 curves, total curvature being equal to

125 entire circles. The brake shoes on the train, on arriving at these mountains after a run of 3,000 miles, were so much worn that they had to attach two more cars to secure more brake-power; the engine, showing no signs of distress after this remarkable run, was at once returned to duty on the road.

A large portion of the whole route from Pittsburgh to San Francisco is a single-track railway. This train had to pass over four mountain ranges, one summit being over 8,100 feet above tide. The *running time* was at a rate exceeding 43 miles an hour for the whole distance of 3,317 miles, and was completed without an accident of any kind.

Now, what do these figures and this data present to the mind of the *professional man?* What can they present but the fact that such a railway performance stands unmatched and unrivalled by any other railway performance that ever took place in the whole history of railways, and that there is no other place or series of railways in the world where such a thing was possible. It presents other features for reflection, particularly among that class of "croakers" who are continually crying out about the poor, light, rough, flexible American tracks and rolling-stock. It shows one of two things—either that the tracks, cars, engines, officers, employees and management were of the very best possible in every part and department, or that the men who got up and conducted such a railway feat were a foolish, daring and reckless set.

Among the ignorant, American railway tracks are always put down and described as light, poor, flexible and rough, and this, no doubt, is the case in some of the sparsely populated regions of the West where the business is light and the requirements small; but why writers, except with an intention to deceive, should place the tracks of the great trunk lines of America, and many other lines in this category, it is difficult *for a professional man* to conceive. The rails are in most cases of the same weight and material as are used in Europe; the ballasting is as good and, in some cases, better than any I ever saw in Europe. (The Pennsylvania Railway is ballasted with broken stone throughout, even where they run through beds of fine gravel.) The sleepers are of the same kinds of timber and of same dimensions and more of them are used to a mile; the fastenings are good and reliable, and trains are run with as much security and reliability, and on many occasions with as great speed, as in Europe. Now, where does the poverty of

this thing come in? It is a fact that "Jack Frost" does, sometimes, pitch and toss our tracks and break things with a facility that is alarming, but he handles the English-built tracks of the Grand Trunk in Canada with still greater ferocity and want of tenderness, and I can bear witness to the fact that, in Russia, he treats with the same marked disrespect and unmannerly conduct the tracks of the Imperial Nicolai Railway which he puts his adamantine grip on, sometimes just after severe rains have distorted it, and then it has to remain in that condition all winter, while carriages are run over it at 40 miles an hour. Mr. Winans told me, in St. Petersburgh, in 1866, that he could find no wheels that would stand the severity of that traffic in winter but the cast chilled wheels, and that he had wheels then on the road of Salisbury iron that had been running 15 years.

It may not be uninteresting to state that American railways have been so often and so persistently decried that many Americans, who never carry any thinking or reflecting apparatus about with them, and who have been told in England that our tracks are so poor, join in the cry and belief that all American railways are but flimsy affairs anyhow, and this, too, after traveling thousands of miles without ever seeing or hearing of an accident. The great mass of people in this world are not willing to be troubled with thinking for themselves, but are ready to pin their faith on the preachings of some one else. Doctor Lardner, in his *Railway Economy* of 1850, page 400, says, "With an experience of twenty thousand miles of railway traveling in the United States, I have never encountered an accident of any kind or heard of a fatal or injurious one. The form and structure of the carriages is a source of considerable economy in the working of the lines." Having given an Englishman's opinion of American railways, let us jump over the Atlantic and take an opinion or two on the other side. Some years since, being in London, an English engine builder long in charge of one of the most noted works in the "States," wrote to me from Edinburgh, saying, "I came up here from London last night, and never had such a shaking up in all my life." I had been that day down to Portsmouth, and returned so tired out from the shaking I had received that I could join my condolements with the man in Edinburgh.

During much of the past two years I have been traveling over the length and breadth of Europe with two young ladies in my party, and found them often exclaiming, "Oh, I cannot stand

this shaking; I cannot read a word; this car is bad; this road is rough."

Did it never occur to any one that a carriage, which could not run steady even on a good track, must be a source of injury to the permanent way and to itself, and that it was playing mischief with the power of the engine? There lies some of the reason why the English engine, on the best of tracks, cannot utilize as large a percentage of its power as is commonly done by American engines on the *poor, light, miserable tracks* of the "States."

Another point that deserves notice—among the common sayings in reference to the American railway system, is that American engines are flexible like a basket, and are pretty good on our *light, rough, poor tracks,* leaving the inference to be drawn that they are not suited to, nor would they give good results on the heavy and perfect tracks of English railways. What can be more preposterous—to think that an engine that can do its work well and safely on a rough track is not a reliable engine on a smooth and good track, is a ship that can—

> "Walk the waters like a thing of life,
> And seem to bid the elements to strife,"

—a poor and unreliable craft on a smooth sea? The veriest tyro in mechanical arts can know, and must know, that an engine that can run with ease and safety on a rough track must be a good engine and a money-saving engine on a smooth track.

Having said so much about American engines, let us see what Mr. Zerah Colburn, the "*engineer of considerable eminence,*" says about English engines in an editorial in *Engineering*, Oct. 16th, 1868, Vol. 6., page 345. He writes as follows: "Locomotive Engines.—Although locomotive engineers are plain, practical bodies, they would no sooner listen to any proposal to give it new forms, than would the genius of sculpture, or his chosen disciples, to transform the '*chef d'œuvre*' of the Belvedere Gallery into the traditional tripodal aboriginal of 'Manx.' The locomotive engine is,—as the locomotive engineers would, we are sure, say,—a heaven-pacing 'Pegasus,'—good-looking as may be he is, nevertheless, the greatest beast that paweth the valley, and his pawing is really more than the valley can withstand. In plain English, the locomotive of 1868 is a monster, which all good engineers should unite to destroy. He is a stalking-horse of railway bankruptcy, the gaunt steed of

railway ruin. It is time he was off to the 'Knackers,' and his carcass sold for what it will fetch in gun metal (precious little) and old iron. There are several counts of the indictment against this beast. But chiefly he will perform his plunging, racing, backing, gibbing and shying only on an iron railway, and of his sextupedal or octupedal hoofs there is generally one pair on which from ten to fourteen tons of his carcass are supported. With these he will often 'let out' in a manner to grind fire from the rails. (No railway ought ever to be strained with a load of more than four tons to a wheel.) He has grown altogether too big, and he must either have more legs put under him or else be knocked in the head.

"When the beast has eight, or ten, or twelve legs, as some of them have, in turning a sharp curve the off-wheels are playing mischief with everything on that side. The fact is, very long-bellied horses of the breed we are now dealing with will never ride well in the 'Ring.'

"Dropping metaphor, eight, ten, or twelve-coupled engines having, therefore, necessarily long wheel bases, tear the way to pieces and themselves too. The system of engine building, which requires a permanent way twice as strong as is necessary for the paying load, including wagons to be drawn, is, on its face, wholly wrong, and nothing but habit and an almost pagan veneration for the outward form of the locomotive, as 'George Stephenson' left it, can account for the long continuance of a practice so palpably vicious," etc., etc.

The proper counterbalancing of engines was a matter which Mr. Colburn, on several occasions, undertook to preach a reform in the railways of England, but as far as I know, with little success. The great importance of this matter had been clearly stated by Geo. Stephenson many years ago. D. K. Clarke, in his great work on locomotives, declares the importance of it, lays down the laws governing it, and describes the rules that should be followed in counterbalancing an engine to make it run steady. Colburn took one of the heavy four-coupled engines of the South-Western Railway of England, counterbalanced it correctly, then run it at the rate of 60 miles an hour with perfect steadiness; he then took out his counterbalances and returned it to its former condition. In that state they did not dare to run it at over 20 miles an hour, and at that speed they found the oscillations so violent and the concussions so great that they broke two strong hooks between

engine and tender. This engine was called the "Norman." Another of same set, called the "Canute," was properly counterbalanced, and showed a saving of 4.20 pounds of coal per mile, or 20 per cent. of total consumption. Four of their engines were properly counterbalanced, and showed an average saving of 3 pounds per mile after a total mileage of 108,941. For this data and other similar data, see Colburn's great work on Locomotives, page 253. The latter half of this work was compiled by D. K. Clarke, after Colburn's death, and he became responsible for the contents.

I met a Polish mechanical engineer at the Paris Exhibition who had been much on the railways in the States, and who was interested in locomotives. I found him most enthusiastic as to American engines. What he said to me he afterwards put in writing, it was chiefly as follows: "All our engines on the continent are patterned after the English; they are all unsteady in motion; it is no exaggeration to say that, compared with the American, riding on them is like riding on a car-horse and an Arabian. This unsteadiness of motion diminishes the effective tractive power and increases the wear of the road. European engineers, those especially who visited America during the 'Centennial,' say that European locomotives would soon destroy American roads. Do they not thus admit the superiority of the American motor? How strange it is that they do not consider it important to have their locomotives so constructed that they can diminish the wear and tear of their roads and increase their effective power. I had the intention to take a trip on a locomotive from Paris to Troyes, but I had to give up after some 80 kilometers—not being able to stand the shaking. This never occurred to me in America. I asked the engine-driver how he could stand such severe service; he said, 'the company take care of me when I am ill, or I would be obliged to give it up.'

"During the Philadelphia Exhibition, an Austrian engineer was charged with making a detailed report on American locomotives. He speaks at length about the steadiness with which they run.

"Some years since, in Vienna, a premium was offered for a design of a locomotive that would run steady at high speed. The locomotive adopted was nothing else but an imitation of an American standard locomotive. The success would be greater if the American locomotive was wholly copied."

So much for the Pole's opinion on steadiness. Let us see what others say. Mr. A. D. Smith, Locomotive Superintendent of State Railways in New Zealand (all 3 ft. 6 in. gauge), writing, in Oct. 1878, about the first American engines erected there, says, "These engines are giving the greatest satisfaction. The engine 'Lincoln' has run, up to Oct. 8, 22,474 miles, (equal to 47,000 miles a year,) in 147 days, at an average speed of 25 miles an hour."

At this same time, the Secretary for Public Works of India writes, that on account of the unsteadiness of the engines (all English) on the State railways in India (all of meter gauge), he has been forced to reduce the speed to 15 miles an hour.

I wonder if this is not something for a *professional man* to reflect on; if it is not, I would recommend him to study a most exhaustive report published by the Government of Victoria, Australia, on the merits and demerits of the locomotives built at Melbourne. This report shows that these engines had the remarkable ability, when running on *straight lines*, to move the whole track bodily sideways three inches, and kink the 80-pound rails in lengths of 5 feet. One of the witnesses, when asked to explain the motion of one of these engines, said: "Well, sir; it looked very much as if one side of the engine was trying to get ahead of the other." This report was drawn by a Commission of Locomotive Superintendents of railways of different Colonies of Australia. It grew out of the report of Mr. Higinbotham, Engineer-in-Chief of Victorian Railways, to his Government on American and other railways, in which report he condemned the Melbourne-built engines as poor and inefficient. I will give, in an appendix to this letter, some extracts from this report of Mr. Higinbotham on American railway rolling stock, first stating that he came to this country, as he admits himself, decidedly prejudiced against things American.

The labored arguments that from time to time appear in *The Engineer* to show that the American engine is a "myth," and that all that is claimed for it is mere "moonshine," are often very amusing and bring to mind the many editorials in *Engineering*, holding up that paper to ridicule, and in no stinted terms measuring out the paucity of talent and knowledge that conducted its destinies. If it had been entitled an "English Trade Circular," devoted to bolstering up crude and fallacious mechanical devices, instead of holding up its head as the ex-

ponent of scientific research and mechanical progress, it would have come nearer hitting the mark of truth and accuracy. There was a time when *The Engineer* could afford to soar pretty high in the world of engineering minds. But those were the days when Colburn directed its editorial pen. Alas, for those days and the early days of *Engineering*! they have gone like the baseless fabric of a vision bent on a wrecking expedition. Colburn, with all his cleverness, and rising like a meteor, flashed for a while, and then sunk himself and his paper so deep in the mud of venality and vituperation, that it has been no small job for his successors to dig the paper out, and set it on the high pedestal it once occupied.

Recently some small papers in the far east, finding that certain Governments in Australia and New Zealand had, in the spirit of progress and economy, ordered rolling stock from the "States," and feeling not only very patriotic but very virtuous, considered it their bounden duty to join in the key-note of the hue and cry set for them by *The Engineer* in a crusade against American railway plant. They are right; I would do the same myself, if I were in their place, but I would, in the first place, try to not get in the position of a tool for any trade-circular. And in the second place, I would try to not make a fool of myself by assertions that any tyro in railway matters must know to be untrue.

It appears to hurt the consciences of some of these worthy editors that British gold borrowed to assist the colonies in railway construction should be sent to America for engines and cars. This is certainly very naughty; but I suppose the Governments that borrow have some good reason to give for the way in which they spend their money, just as certain bankers in Paris, some years since, decided that they would not loan the money required for a new line of steamships, unless the promoters agreed to have the engines built in England. This was, no doubt, naughty also. But the bankers may have had a reason for it. And they were probably not as much in the dark about the reason as Rogers was when appointed poet-laureate, and said to a friend:

> "Once on a time they promised me reason
> for my rhyme.
> But from that day to this season I have
> seen neither rhyme nor reason."

Large sums of money are drawn, no doubt, from the pockets

of Englishmen to build railways in New Zealand, and I have no doubt but that they would, if asked about how it should be spent, say, "Go and spend it where you can get the most for the least, only for heaven's sake make sure to give us our interest regularly." The amount of money loaned in this way to New Zealand, is but a "speck in the bucket" to the vast sums loaned to railway companies in the "United States" and "Canada," and yet these "Yankees" and Canadians are so unmannerly as to spend it all on this side of the water. The "Canadians" in this are worse than the "Yankees," for they come down here with British gold in their pockets to buy engines, bridges, &c., knowing that they will have to pay 17½ per cent. duty on their going into Canada, and also knowing that they could get engines and bridges from England without paying any duty. There must be a reason for this, other than mere love for their neighbors.

A few days since, I saw a large amount of tramway cars boxed and marked for London. These cars were, no doubt, paid for in British gold, and were going to the very heart of the British empire. This was another naughty trick to get rid of good gold in an alien country. There must have been some reason for it.

The Chairman of the North Metropolitan Railway Co., of London, some three or four years since, in his annual report, told his shareholders that their city-made cars had a life of only 4½ years, while the cars made in New York were found to be much superior. He had, no doubt, discovered that the tramway-cars built by John Stephenson, in New York, had an average life of 25 years, and that they were in use in all parts of the world. Surely there must be some reason for these cars lasting so unconscionable a time, seeing how "poor materials" and "execrable" workmanship we use in all our railway "plant."

The Otago *Times* is a firm believer in the preachings of the "*Australian Engineering News*," (a paper recently started, I am told, in the interests of Fairlie,) and speaks of a "clap-trap" editorial of that paper as an "able article that fits our mind conclusively." Any article can be made to fit an ignorant head. That little head of the Otago *Times* says, that the bar-frame of the American locomotive was introduced because it was flexible, and that it was done at the expense of strength and stability. Every railway child must know that the very reverse is the case. It was adopted because it was less flexible,

stronger and more stable than any slab frame can ever be made. I intend to touch on this frame point again, and give some clever English engineers' opinions on it.

Bogies under tenders are another contrivance that does not suit the Otago mind. It says that brakes cannot be applied to them. Why not? They are on the bogies of every locomotive tender in the "States," as well as on the bogies of all cars, and are found efficient and reliable.

Other trumped-up objections are, that "poor materials" are used in American locomotives, that they are short-lived, work execrable, etc., etc. I intend to give answers to all these points in an appendix, and chiefly from the pens of clever English writers, *professional men*, whose liberal minds have not been cramped up in the small quarters of those who carp at everything, and particularly American things.

This matter reminds me of what a gentleman from Melbourne told me of the love of abuse by the editors of that city. In referring to the first Governor of Victoria, Mr. La Trobe, he said that man was the best governor they ever had; honest, talented, and energetic. He did wonders for the infant colony, but he was so badgered and abused that he was driven from the colony by a set of howling editors, and is now living on a small pension in London, while some of these same editors are living there in elegance on their ill-gotten gains.

A junior partner in a law firm, once asked his senior how he should conduct a case. He answered, "Why, by argument deduced from the merits of the case." "But there are no merits, and no argument to offer," said the junior. "Then," said the senior, "abuse the plaintiff." This appears to be the rule of action—the human nature of those weak brains that are eternally carping at things they cannot understand.

I might here state that the specification for American Engines are not left to the builders, as these writers assert, but are drawn up with much care and in complete detail; also that American Engines are not in many cases "mere duplicates of others." The first engines built for New Zealand were different from any built before, and some delay, as well as considerable cost, was occasioned by having to make for them an entire new set of patterns. These are the engines Mr. Maxwell puts down as costing £2,800 each, and which cost really only £1998.

It is contended that, for the colonies, engines, and all classes of rolling-stock can be got as good and as cheap in England as

in the "States;" if so, then they ought to be got there. Any colony that would be going out of the limits of itself or its mother-country, to get any thing without some good and valid reason, would, in my opinion, be doing an unjust and an unnatural act. It is contended that rolling-stock can be built as good and as cheap in New Zealand as it can be here; if so, it ought to be built there. It is easy enough to try the merits of this policy. I saw it tried once in South America in the matter of cars. It turned out fallacious, as the cars cost just double the cost of those they imported.

I beg to say in concluding this already too long letter, that it is not written for the purpose of converting any one, or is it written as a trade circular, or to advance my own personal interests, for I am not seeking or asking for business of any kind, nor do I expect any profit or compensation from any source, except the satisfaction that may result from throwing light on an important subject, with a faint hope that it may assist in removing the blindness of prejudice and the folly of error.

A man that has had the honor to write, by request of the British Government, an opinion on railway economy, and then refuse to receive any compensation, except thanks, from so high and mighty a patron, while others were asking and receiving fees far beyond £10,000 for similar opinions, need not fear that his acts will be misconstrued, or attributed to any feeling but that of love for progress, prosperity, and the diffusion of knowledge among men.

I have the honor to be, sir, your obedient servant,

W. W. Evans.

Member Institution of Civil Engineers,
Member of American Society of Civil Engineers,
Member of Council American Geographical Society.

P. S.—I must not close this long, and no doubt tiresome letter to some to read, without offering my sincere thanks to Mr. Maxwell, to the editor of *The Engineer*, and other editors, for giving me a chance to ventilate this important matter of American Railway Plant more thoroughly than it would have been done otherwise.

THE TESTIMONY.

AN APPENDIX,

Giving the opinions of several clever and well-known English engineers on the merits and peculiarities of American locomotives and railway plant.

As some of these extracts are taken from the proceedings of the Institution of Civil Engineers of England, and as those publications are not to be purchased, nor are open to the public, they may meet the eyes of some who would not see them otherwise, and will, I am sure, be read with interest by all who desire to see railway progress and who study railway economy.

Extracts from the Report of Thos. Higinbotham, Engineer-in-chief of Victorian Railways, to Parliament on the Railways of the United States, in 1875.

Page 4. "I rode on the engine crossing the Sierra Nevada Mountains; the speed on falling gradients was very great, but the drivers appeared to have perfect confidence in their engines. I had opportunities of speaking to several drivers, Englishmen, who had driven engines in England, they all preferred the American to the English engines."

Page 12. "At Toronto, Canada, there are two railways of 3 feet, six inches gauge. The Nipissing, 88 miles long, and the Toronto, Grey & Bruce, 190 miles long.

"These two lines were stocked at first with engines and carriages and wagons built in England, which proved complete failures, and have been replaced by American engines and carriages; these are found to work well. The rigid wheel base of the English rolling stock, the small wheels, and the radial axle boxes, had been tried and condemned. The original rolling stock was of light construction.

"An accident happened on the Nipissing line; a train left the track. I was informed that after the accident nothing was left of the rolling-stock but the wheels. The rolling-stock now used is as strong as that used on a road of 4 feet, 8½ inches gauge; it is found to be much more economical than the light stock. The Master Mechanic (locomotive superintendent), who is an Englishman, told me that he preferred American to English engines and rolling-stock for railways in Canada."

Page 20. "The bogie truck and cast iron wheels are two of the most important features of American engines and rolling-stock.

"On the Grand Trunk Railway of Canada, neglecting the experience gained in the States, English engines and rolling-stock were tried, but had to be abandoned, and the American type adopted; very recently, the same mistake was made on the Narrow Gauge Railway of Canada, and with the same result. The chilled cast iron wheels stand well; they are safer in severe frosts than those with wrought iron centers and steel tires, because they are in one piece. It is well known in England that some of the worst accidents have occurred from wheel tires breaking in frosty weather.

"There has always been a distrust of cast iron wheels in England, but it is impossible to resist the testimony in favor of the safety of the cast iron disc wheel which is used in the States. I feel convinced that the best of these wheels are as safe as the best wrought iron wheels in any climate, and that they are safer than wrought iron wheels with steel tires in countries subject to severe frosts.

"I did not go to the States at all prepossessed in favor of American engines; but what I saw there satisfied me that for the light railroads of this country they are better adapted than any others. I am of the opinion that it would be a wise course to obtain engines from the States. The vast system of railways in the States, extending over 70,000 miles, has led to the establishment of great works with the most perfect machinery for the manufacture of locomotives. The competition between these works secures first-class engines at moderate prices.

"The express trains on the London & N. W. Railway are drawn by engines with two pairs coupled. The practice on this railway has, admittedly, been influenced by that of the United States in this respect and corresponds with it."

Page 60. "Iron tubes are used in the engine boilers in Switzerland, and are found to be more durable than those made of brass or copper."

Page 66. "All the mistakes in the construction of engines and rolling-stock of the narrow-gauge railways of Canada, which have been corrected at great expense, are being repeated on the metre-gauge railways of India."

NOTE.—The above is pretty plain writing for a man that came to the States prejudiced against American railway appliances. But Mr. Higinbotham was an educated gentleman, in search of the truth, traveled with his eyes open, and had the courage to tell what he saw honestly. The London *Engineer*, in reviewing this report, allowed the following to slip, I suppose, by mistake, into its columns: "Now it is true that English engines on English roads very seldom run off, but this results not from the merits of the engine, but from the excellent qualities of the road. And it is worth considering whether an American engine, which is capable of running well on a road which sets an English locomotive at defiance, might not be found to run more *lightly*, *cheaply* and with less practical resistance, and less wear and tear of track than an English engine."

Surely *The Engineer* can "blow hot" and "blow cold" when it is in a disposition to blow either. W. W. E.

In the centennial year 1876, Mr. Massey Bromley, a highly educated and experienced English engineer, works-manager of the Great Eastern Railway of England, came to this country expressly to study locomotives. He brought me letters of introduction. He was soon put in communication with the best men, and had a chance to see the locomotives and practice of many railways. At the end of his 100 days furlough, he came back to New York and said to me: I am going home to build American Locomotives. I (E) said, I doubt you very much; I do not believe you will build driving wheels as we do. He (B) said yes, I will, I believe them to be better and much cheaper than our wrought wheels. (E). Well, how about the frames, are you going to adopt our frames? (B). No, we cannot afford that; your frames are too costly for us. (E). Well, what type of engine are you going to build? You say your railway company are going into the coal business. (B).

I am going to build engines like your Moguls. (E). Why not adopt our Consolidation engines? they are the fellows for the coal trade. (B). Oh! they are too advanced for us; our directors could not understand them. We have not a siding on our lines that could hold the trains they would haul. (E). But why not lengthen your sidings and get the full economy of the thing at once. (B). No, they would not listen to such a thing.

W. W. E.

Extracts from the Report of Mr. J. Boyd Thompson, General Manager of the Northern Railway of Buenos-Ayres, to his Directors in London:

BUENOS-AYRES, June 27th, 1867.

"Our present stock of first-class carriages consists of ten English and two American; the last with seats for 64 each and weigh 10 to 11 tons, or 385 pounds per each passenger. The ten English seat 60 each and weigh 16 tons, or 597 pounds per each passenger, or 212 pounds for each seat more than the American. Three American seat 72 passengers more than two English and weigh one ton more.

"During the past ten months the ten English carriages cost $40816 currency for repairs, whilst during the same period the American have cost nothing for repairs, and are at present in better condition than those made in England, though they have been in constant use since the line was first opened. I may also remark that their chilled iron wheels scarcely show any perceptible wear.

"The American carriages are, in every respect, better and more comfortable, requiring less than one-half the power to propel them that is necessary for the English.

"It has also been proved that the English carriages are much more injurious to the permanent way and works, and likewise, in proportion, injurious to themselves than those of American make.

"I beg to conclude these remarks with strongly recommending the American-made carriages and wagons, and from experience of their working on the 'Boca' and this line and their fitness for our traffic. They cost less, are not so expensive to keep in repair, run easier, and cause less wear and tear on the permanent way."

NOTE.—The accuracy of the above can be verified at the office of the Company in London. It appears to be pretty strong testimony coming from a Scotchman who had never been a day in the United States, and was certainly under no American influence. The $40816 for repairs was, no doubt, in depreciated currency far below gold value. This report was sent to me from London, in print. I have never seen this Mr. Thompson, or any officer of that railway.

Mr. Thompson had no American engines on his railway, so he could not add his testimony on that point. Messrs. Brassey, Whythes & Wheelwright, contractors for the Central Argentine Railway, sent me an order for all the rolling stock for that great railway. I had to write them that I could not send the engines if they gave £10,000 for each, as it was in the midst of our civil war, and all the locomotive works were fully occupied by the Government. Years after this, Mr. Wheelwright wrote me of the engines he had on that railway (over the Pampas, nearly level, and almost entirely straight from Rosario to Cordova, 243 miles), and said: "You would have saved us a mint of money if you could have sent us American engines." I think the English railway world will admit that that firm had pretty "level heads" on their shoulders and knew what they were about.

W. W. E.

Extracts from an Article on American Locomotives, published in *Engineering*, in 1871; by A. Brunner, Engineer of Cockerell Works, at Seirang, Belgium.

"The American railway engine, as compared with European locomotives, bears upon its face the stamp of much fertile originality (similar to that of American steamboats and bridges), when confronted with transatlantic work of a kindred class....... I have examined American locomotives in detail at the manufactory; witnessed their performances on all kinds of track, and I am compelled to confess that what I saw far exceeded my anticipations....... One of the peculiarities in American locomotive construction is the framing, which is made of square bar iron, welded together, slotted, planed all over, and entirely finished. The bar-frames, besides being very rigid in every direction, admit of easy access to the link motion; they form at the same time a good base for attaching the various brackets and guide-plates. The cylinders, which are usually outside, are hung from the top bars of the frames, to insure a firm base for the cylinders; and to prevent independent strains on the frames, a cast iron separate bed-plate, or 'saddle,' is inserted between them.......As a rule, the various details of the motion and gearing are admirably well proportioned and carried out....... The cast iron wheels form

another distinctive feature in American practice. The small, chilled, cast iron disc wheels of their engine-tender and car-trucks answer admirably well, being cheap, strong, and durable at the same time....... Much ingenuity is displayed in the manner of setting engine and tender on the wheels; in fact, the problem of making an easy riding engine, offering at the same time, the least amount of internal resistance, has been solved by the Americans most successfully. Much might be written on the history of the swiveling truck, the faithful 'trackfeeler' of the American locomotive; it would take a graphic pen to record all the modifications this useful contrivance has already encountered....... In outside appearance and finish, the American locomotives present much original conception, and not unfrequently real artistic merit. The Yankees seem to place great pride in their engines; and it is indeed a proud sight to see an American engine entering a station, blazing in polished brass, embellished with rich pinture, bells ringing and whistle roaring. We will now proceed to witness the performance of American engines. One of the most striking observations is the ease, not to say 'grace,' with which the comparatively light locomotives do their work—and heavy work, too—over the rough roads of the United States and Canada.

"The average gross tonnage of passenger trains here is probably double that of English trains; still, with from six to seven passenger cars weighing, loaded, about 20 tons each, a baggage car, of same weight, and a Pullman drawing-room or sleeping-car of 30 to 35 tons weight; the engine gets quickly away from the station and without 'slipping.' Of course, there must be some material reason to account for the superior useful effect given by American Engines. . . . . The Baldwin Works have turned out not less than 200 locomotives in the year. Locomotive building, on this Continent, has made great progress of late, as verified by the perfect organization of the work-shops, and the systematic manner in which the work is turned out. My visit to this great country has made a lively impression on me, which I am sure will be shared by most impartial critics, that in the specialty of locomotive construction, the Americans are fully equal, if not ahead, of the best European practice."

Dated, MONTREAL, January 1st, 1871.

Extracts from the *London Railway News* for Nov. 16th and 30th, 1872, and Feb'y 22d, 1873.

This paper compared four English and four American railways, putting the Grand Trunk Railway of Canada in among the American, which we decidedly object to.

The *Railway News* says: "Comparison shows that the American engines perform an amount of work altogether unequaled by those on any line in this country. For example, the New York Central, where the traffic is heavier even than on our London and North Western Railway. There are not half the number of engines mile for mile to work it.

"It must be remembered in instituting a comparison based on the earnings, that the rates of transportation are lower in America than in England ; and, therefore, to earn as much per mile as an English train, the American must carry much heavier loads.

"With respect to passenger trains, the American mean average is 6*s*. 5*d*. per mile, against 4*s*. 7*d*. in England; the difference being nearly 40 per cent. The rate of fare is probably about 30 per cent. lower than with us, and this, added to the 40 per cent. of extra earnings, shows that an average train in America must convey about 70 per cent. more passengers than an average English train.

"The American average, it will be noticed, is considerably reduced by the low average of the Grand Trunk Railway, and we are, therefore, probably within the mark in putting the difference in favor of the American train at 70 per cent. The New York Central average of 7s. 1d. per passenger train mile, is probably the best of any large line, and affords a striking contrast with the Midland Company's average of 3s. 11d. only. After deducting working expenses, what a difference there must be in the net profit per mile run by passenger trains on these two lines.

"Comparing the earnings taken in connection with the cost of the plant, the earnings of the four English companies is £4,662 per engine. In America, on the other hand, the engines earn, on an average, no less than £7,963 each, and on the Lake Shore line each engine actually earns £8,765 a year, or more than three times its present value. Altogether, it would appear that an American locomotive earns somewhere about 70 per cent. more in a year than an average English one.

"The very same result, singularly enough, appears when the

earnings are taken in relation to the original value of the rolling stock on the lines.

"The rolling stock on an English railway may be said to earn its own cost in a year; but in America it earns its own cost and 65 per cent. additional."

The *Railway News* shows that the earnings of the London & N. W. R'y, in 1871, was £4,856 per mile, that they operated 1,614 miles of railway, and had 1,791 locomotives.

That the New York Central Railway had earnings of £5,417 per mile, operated 845 miles of railway, and had 423 locomotives.

This data reduced shows that the New York Central earned, per mile of road, £561 more than the London & N. W., and that it did its work with fifty-hundredths of a locomotive per mile of road, while the London & N. W. Railway occupied the services of one and eleven hundredths of a locomotive per mile of road, to say nothing of the New York Central having more severe gradients, curves, and climate to work in, and doing its work on what are considered to be in England, "poor, miserable, light, loose tracks."

NOTE.—As the Grand Trunk Railway, of Canada, has been introduced in these comparisons, I beg to pay my compliments to it in this connection of comparative merits of American and English engines. Indians are said to be not satisfied with one "scalp," they must have a dozen or more.

As I do not intend to be ever again induced to "enter the lists" in favor of or against anything appertaining to railway rolling stock, I may as well have my say out, and knock down all opponents so they cannot get up again, or at least make a bold attempt in that direction.

The Grand Trunk Railway was built by English engineers with English capital. The engineers boasted on more than one occasion that they were going to show the "Yankees" how to build a railway. It was stocked originally with English engines and cars, and has always been managed by Englishmen. When this great line of over 1,400 miles had been brought to the very verge of bankruptcy by excessive expenditure in construction, and by the use of English rolling-stock, they were forced to open their eyes to the merits of American engines and cars, and adopt them, paying at that time 12½ per cent. duty on the American engines going into Canada. In 1859 this railway company had 203 locomotives, 50 built in Eng-

land and altered in Canada to American patterns, 110 built in the United States, and 43 built in their own shops after American patterns. This company also adopted the long American car on two bogies, oil-tight boxes, the cast-iron chilled wheels, and center buffers, all belonging to the American system. In November, 1874, the Grand Trunk Railway had in use 434 locomotives, 328 built in the "States," 49 built in Canada, and 57 built in England by Neilson & Co., and "Canada Works," Birkenhead. This change to American rolling-stock was a necessity. Without it this railway would soon have become hopelessly bankrupt, and over one hundred millions of dollars of British capital sunk out of sight. The directors and engineers in Canada saw that it was impossible to contend with the "Yankee" trunk lines, for the great and ever-increasing business of the "West," without making great and radical changes in their rolling stock. They bowed gracefully to the governing circumstances, and ordered the changes to be made. The company in London were not prepared to swallow unresistingly this bitter and expensive remedy. On receiving a report from their mechanical engineer in Canada, showing that he was altering the engines sent from England to Yankee ideas of fitness, they ordered him home and sent out another, who said he would soon stop this Yankeefication of the engines. But very soon after his arrival in Canada, he became a convert to the necessity of a change. The proximity to Yankee-land had its impressive features, so the new locomotive superintendent "pitched in" to complete with all despatch the changes commenced by his predecessor.

About this time Mr. Alex. M. Ross, the engineer-in-chief of the Grand Trunk Railway, in writing to Mr. Geo. E. Gray, an old assistant of mine (and then engineeer-in-chief of the New York Central), said: "On the breaking up of the frost in the Spring, we never could keep the English engine on the track, except at a slow speed, which defeated our object."

W. W. E.

Extracts from *The Engineer*.

Oct. 1, 1858.—"As opposed to Mr. Tait's opinion of American locomotives, Mr. Robert Stephenson stated, while in America, that the engines of that country were *better* than those of En-

glish build, while the same gentleman, to the knowledge of the writer, has reiterated the same opinion within the last ten days.

"That American locomotives are, at least, of a fair quality of workmanship, may be presumed from the fact that they are worked to a load averaging 20 per cent. more than that of English engines."

Oct. 29, 1858.—The peculiarities of the American locomotives, which were last season very fully explained to us by Mr. Neilson, (locomotive builder of Glasgow), are attracting attention in this country, from the good adaptation of these engines to steep gradients and sharp curves."

Data from a letter of Mr. Howard Fry, Locomotive Superintendent of Philadelphia & Erie Railway, to Mr. J. F. Robinson, in reference to the performance of a Baldwin Consolidation Engine, No. 41, on that railway, Oct. 27th, 1877:

(This Mr. Fry is an English Mechanical Engineer of experience and ability, and is held in high esteem by all the railway engineers of the United States.)

"The engine No. 41 had cylinders of 20x24 inches; four pair driving wheels coupled, 48 inches diameter; weight in working order 102,000 pounds; weight on four pair coupled 88,000 pounds; total wheel base 22 feet, 10 inches; rigid wheel base 9 feet.

"Train consisted of 100 American eight-wheel cars, 87 loaded with oil and 13 with grain; weight of, including engine, 2,201 tons of 2,240 pounds each; length of train, excluding engine and tender, 3,127 feet; distance run, from Sunbury to Dauphin, 45.5 miles; time 4 hours, 21 minutes, or 10½ miles an hour; line practically level; minimum radius of curvature 860 feet.

"This engine made 26 double trips in this month of October, running 2,340 miles, or at the rate of 28,080 miles for the year. one day it hauled 106 cars, and averaged 90.3 cars per trip for each day in the month. This engine has made a car-mileage of 192,009, with a consumption of fuel of 1.8 pounds per car-mile."

Note.—If any one in Europe can match this performance of No. 41 with any engine they have there, I will be much pleased to see them trot it out and give us the figures. Our engines may be "miserable affairs," made of "poor materials,"

with "execrable workmanship," "loose-jointed," "flexible like a basket," etc., etc., but they do their work in a most miraculous manner, earn piles of money for the shareholders, seldom ever complain, enjoy good health, win friends, and live to a good old age.

W. W. E.

Extracts from a letter of Howard Fry, Mechanical Engineer (in charge of Motive Power of Philadelphia & Erie Railway, a branch of Pennsylvania Railway), to W. W. Evans, dated February 11th, 1880.

"There are points of difference between locomotives, such as are generally turned out of English and American shops.

"Generally English engines have frames made of iron plates; these plates, if the engine is a heavy one, are of such size that out of England they are difficult to procure, so that in the colonies the breaking of a frame is a serious matter.

"In an American engine the frames are usually iron bars. They can be made in any country where bar iron can be bought, and if broken can be welded up as good as new in any shop where a blacksmith's fire can be rigged.

"Driving wheels in English engines are generally of wrought iron, and can only be made by smiths specially trained to the work and with suitable appliances, so that if new ones are needed in any country but England, it is necessary to import them. But the American wheels are cast, and do not require exceptional skill to mold, so that a superintendent of American engines is under no more necessity to import driving-wheels than axle-boxes.

"It is generally considered American practice to use steel fire-boxes, and in English practice copper, but many exceptions can be found in both countries. Copper fire-boxes are, I believe, more often put in in America than steel in England. Possibly English steel plates cannot be trusted for this purpose as well as American.

"The cab in English practice is generally made of iron, and if broken requires a skilled plate-worker to repair, while the American cab, being of wood, can be repaired or a new one built by any native carpenter. There is, too, a marked difference in the provision for comfort of the driver between an English and American cab. The English rarely provide seats,

and in arrangement of windows and inside fittings appear to care nothing for the man in whose care the engine is to be.

"In Canada, where both English and American engines have been used, it has often been found that the company sustained serious loss from the inability of the men to remain on their engines. If stuck in a snow-drift to abandon their engines and let them get frozen on the road, is a very serious matter; and when several nights have to be spent in a drift, with the mercury below zero, cushions to lie down on, and curtains to keep out the cold, are more than mere luxuries.

"The locomotive superintendent in the colonies, who buys an American engine finds that he can repair, and if he wishes, reproduce it in his own small shops, and it does not always follow that the superior material and form is worth its extra cost. . . . . All this may help to explain why engines are built in America, in spite of high wages and excessive cost of material, cheaper than engines for similar work are built in England, and partially accounts for the popularity of American engines. Wherever they are tried, as in Canada, for instance, where the railways are all officered by Englishmen, who come to Canada with a strong bias in favor of everything English, but who have in every case adopted finally American types in their locomotive practice.

"I do not know where there are any English-built Engines suitable for comparison with American.

"I never yet saw an English engine at all suitable for the average colonial or American service.

"All the English engines in Canada were completely unfit for the work they were designed for, and have so universally been condemned that England has lost the entire trade of this her nearest colony, and of the hundreds of locomotives ordered since the Grand Trunk Railway changed its gauge, not one has been obtained from England.

Now, this does not prove that English Engines are worse than American, or that English firms cannot build engines to run on our lines; it simply shows that English firms have not done so thus far."

NOTE.—The writer of the above letter, Mr. Howard Fry, is an accomplished English Mechanical Engineer, of long experience in England, Canada, and the United States. He is well known among the engineers of the States as a man of marked ability and extensive knowledge of all things relating to railway machinery. His opinion carries weight with it among all American Engineers, and I feel sure it ought to be respected wherever it is known; and I also feel sure that in

writing and giving his opinions on railway machinery, he is actuated by the same motives that govern me, namely, to be honest, and do what in him lies to promote "Railway progress" and "Railway economy" throughout the world, without reference to vain nationalities, or stopping to consider who is knocked down or who is set up.

W. W. E.

Data from letters of Vice-President Strong, I. A Burr, Engineer, and G. Hackney, Locomotive Superintendent of Atchison, Topeka & Santa-Fe Railway, in reference to the Baldwin Consolidation Engine "Uncle Dick," running on the Raton Mountain Division, March 1879:

"DIMENSIONS, ETC., OF ENGINE.—Cylinders 20″ x 26″; total wheel base 22′, 10″; rigid wheel base 9 feet; weight on drivers, four pair coupled, 100,000 pounds; total weight, including 1,000 gallons water, 115,000 pounds; diameter of driving-wheels 42 inches; total heating surfaces 1,377 square feet; gauge of road 4 feet, 8½ inches; maximum gradient for 2½ miles 1 in 16.5; minimum curvature 360 feet radius.

"This engine has hauled, at 6 miles an hour, nine American cars, with 12 tons on each, over this maximum gradient, or 173 tons exclusive of engine. On 1 in 50 it has hauled 430 tons at 8 miles an hour. On 1 in 33.3 it has hauled 230 tons at 8 miles an hour. (Tons of 2,240 pounds.)

"The above loads are started from a stand-still, without taking the slack of the train, and without slipping the drivers."

Extracts from the Paper of C. D. & F. Fox, No. 1,332, read before the Institution of Civil Engineers, in 1874, on Pennsylvania Railway, and the Discussion on same:

Page 4.—"The Messrs. Fox show that the net earnings of this great railway were, for thirteen years, a little over 12 per cent. per annum on the capital, and that from 1853 to 1873 the company have paid an average yearly dividend of 9.9 per cent. and a total in dividends of 234 per cent. in 20 years on the entire capital cost. This wonderful result, we are asked to believe, was accomplished by the use of engines and cars of miserable construction."

Page 8.—"This railway has in use seven different classes of engines. Much attention is paid to interchangeability in con-

struction. An idea of the uniformity practiced is shown by the fact that while 112 patterns are required for one engine, only 187 are required for all the seven classes.

"The trucks have chilled cast-iron wheels. Steel wheels have been tried, but it was found that they would not stand the severe work of guiding the locomotive over the sinuosities of the line. Solid cast wheels, with the running surface chilled, are the safest, especially in cold weather, a truck wheel of this kind rarely breaking, and one such wheel outliving, at least, three steel wheels. Again, the flanges of chilled wheels are soon made smooth and highly polished by wear; while the flanges of steel wheels soon become rough and torn and, in a short time, too thin and sharp for safety. Chilled cast wheels are used for the rolling stock, steel tires having been tried for the passenger cars, but quickly became dangerous from rapid wear."

Mr. F. W. Webb (Mechanical Engineer of the London & North-Western Railway) said: "He had spent a good deal of time on the Pennsylvania Railway. The locomotives had much smaller driving-wheels. Since his visit to America he was running some of the fastest express trains, including the 'Flying Scotchman,' with locomotives having driving-wheels of 66 inches in diameter."

Mr. T. W. Worsdell (Second Mechanical Engineer on the London & North-Western Railway, who was in service on the Pennsylvania Railway for some years) said: "During his connection with the Pennsylvania Railway, the company began the manufacture of steel boilers. He had been engaged in the construction of 120 steel boilers, and 250 steel fire-boxes. When the copper-fire boxes were worn out thin crucible steel was substituted.

"He knew from experience that cast-iron valves lasted longer than the brass valves in common use in England. A valve was seldom broken, although the area was large. The Pennsylvania Railway Company were the first to make driving-wheels with hollow spokes and rim. He had never known one of the hollow-spoke wheels to be broken, except in cases of collision or 'jumping the track.'"

Mr. J. Fernie said: "Contrasting the English complicated wheel with the simple American chilled wheel, he was induced to think the Americans were in advance of this nation. From the humblest wagon to the most sumptuous Pullman car, all were

fitted with the simple chilled wheel. In his travels through the 'United States,' what he saw in regard to mechanical engineering—work was of the very best kind. All appeared to aim at perfection, and no expense was spared in arriving at that result. Many revolutions in mechanical engineering had been introduced into this country from America."

Extracts from a paper, No. 1469, read before the Institution of Civil Engineers, in January, 1877, by Alex. McDonnell, on the Repairs and Renewals of Locomotives.

Page 20.—Mr. McDonnell gives some of the statistics of the Reading Railway of Pennsylvania, furnished to him by the General Manager, Mr. Wootton. As this railway has much the heaviest traffic of any railway in the world, moving over eight millions of tons in a year, besides a heavy passenger traffic, and being forced, by great competition, to a close study of railway economy, on all points of expenditure, it may not be uninteresting to the *professional man* to state some of this data given to Mr. McDonnell.

The importance of a close study of economy on this railway was made evident by the President, Mr. Gowen, in one of his annual reports, when he said that an additional charge of one-twentieth of a cent per ton per mile in their coal traffic, would be equivalent to an additional dividend of 2 per cent. on their entire capital.

They had in 1875, on 95 miles of railway, 410 locomotives. The average weight of coal trains, exclusive of engine and tender, was 846.6 tons; average load of coal in trains 666.6 tons; coal used per mile, 121 pounds, equal 0.97 pounds per car per mile; average life of steel fire-boxes, 120,000 miles; average life of copper fire-boxes, 45,000 miles; average life of iron tubes, 138,000 miles; brass tubes under test were found to be so unsatisfactory that they were abandoned.

Mr. McDonnell shows that iron tubes were used on the Great Western Railway of England; that the average life was 180,672 miles run; This makes ten years as the life; taking 17,500 miles as the yearly average of the engines; one engine on this railway run 447,000 miles without the tubes being taken out.

Sir John Hawkshaw said: "He began the use of iron tubes as far back as 1834. It might be interesting to locomotive

men to know that in the United States brass tubes were not now used, nor were copper fire-boxes. All the fire-boxes in the 'United States' were of steel, and the tubes were of iron. From what he had seen and heard in America he thought it worth while for locomotive engineers to consider whether steel fire-boxes and iron tubes would not be cheaper and better than copper fire-boxes and brass tubes. His own opinion was that the change would be an improvement."

NOTE.—The life of steel and copper fire-boxes on the Reading Railway is given merely to show the difference. The life in either case is short in train miles, but might show by comparison with other roads very differently if car miles were used, as the coal trains of this Railway are for summer traffic made up with 125 cars in each, and 115 for winter traffic, the coal carried for years averaging over 524 gross tons in each train.

Sir Charles A. Hartley, in his paper, No. 1,413 read before the Institution of Civil Engineers, in 1875, on the public works of the United States, deals in many complimentary terms of what he saw. He describes the immense business of the Reading Railway, and says that the coal is carried 95 miles for 30 cents per ton, equal to $\frac{1}{6}$ of a penny per ton per mile.

For the benefit of the *professional man*, let us quote a few more scraps from the paper of Mr. Colburn, " the engineer of *considerable eminence*," and the discussion on it at the Institution of Civil engineers in London.

Mr. Hemans said : " He disapproved of the stereotyped make of English locomotives and rolling-stock, and of the enormous weight placed on one pair of wheels, as great in some instances as 18 tons. These weights were very injurious to the permanent way."

Mr. W. B. Adams said : "The frictions of the railway carriage were induced by the cone on the wheels; that loaded trains had stuck on inclines of 1 in 75, and single cars had stuck on 1 in 80, the friction being changed from the normal 8 pounds (as generally allowed for in England) to 28 pounds per ton."

Mr. G. Berkley said : "He was surprised to find that the weight of their wrought-iron wheels was greater than that of the cast-iron in the proportion of 6 to 5, while the cost of the English wheel to the American was as 4 to 2½."

Mr. Bridges, of the Grand Trunk Railway, wrote : "Our experience in the cast-iron wheels is that we consider them far

superior to any wrought-iron wheels that have ever been imported from England. Several hundreds of cast-iron wheels imported from Glasgow were found to be utterly useless."

Mr. R. P. Hodge, said: "He had tried the American oil-tight box on the L. & N. W. Railway; that a set of four had run 21,800 miles with one pint of oil, which oil was taken from the lower chambers, the dirt precipitated, and put back, when they ran the same distance over again. Whatever may be said of American railways, it should not be forgotten that some of the best railways of that country were constructed at a less cost than was paid for the engineering expenses alone of the Great Western Railway of England."

Mr. W. Atkinson, said: "He had visited the States and found the frictional resistances of engine-tender and cars was 4½ lbs. per ton....... The cast iron wheels, the bogie frame, and the large one-compartment cars, had their origin in the extreme rigor of the American climate; the permanent way was frozen so hard, the English composite wheel was shaken to pieces, and nothing but the cast iron wheel could resist the rigidity of the road."

Mr. E. A. Cooper, said: "He had made experiments with the American oil-tight boxes on the South-western Railway; that in one case a force of 2 lbs. per ton was sufficient to keep a car in motion; that at a speed of 15 miles an hour, the friction was 2.4 lbs. per ton, and at a speed of 25 miles an hour, it was 2.8 lbs. per ton. The carriages had been tried in various ways: on a level, on inclines, and with, and against, the wind; the results had been proved in several ways. The experiments were made with ordinary carriages; one carriage, he was informed, had been run 9,323 miles with one pint of oil; the brasses lost one ounce in running 10,040 miles, and after 106,000 miles they were still in fair order. The friction of 8 lbs. per ton, which was common with ordinary grease-boxes, ought, therefore, to become a thing of the past."

Capt., now *Sir H. W. Tyler, Royal Engineer*, said: "The adoption of the bogie and cast iron wheels under all the engines, carriages, and wagons in America, was an interesting subject of inquiry. It could not be from the sharp curves, for the curves, as far as he had seen on many lines, were not sharper, as a general rule, than they were in England.

"Certain engines sent to Canada, of the ordinary six-wheeled coupled pattern of England, would not remain on the

rails, even where there were no sharp curves. Those engines were altered; bogies were put under the leading ends, and they had since done good service."

Mr. W. Lloyd, said: "He had invariably found great economy in the consumption of fuel in the English engines, and that American engines burnt 18 per cent. more fuel than English, as proved by the experiments of Mr. Evans."

NOTE.—I beg to correct Mr. Lloyd in his remarks. Mr. Lloyd was never connected with any railway on which there was an American engine, nor had he ever any personal knowledge of the economy, or want of economy, of American engines. And he is in error as regards the 18 per cent. economy spoken of above, for, in the experiments he alludes to, there was, in one case, 19 per cent. economy in favor of the American engine, and in the other case, 13 per cent. economy due to the English engine; but this would have been made more than *nil*, if the consumption of fuel on account of speed had been equated; as the American engine, in this case, took the same train, on the same road, the same distance, at 42 per cent. greater speed. W. W. E.

Mr. Colburn said: "There was evidence that English engineers and railway managers on going to Canada to take charge of lines owned in England, had, notwithstanding their natural and habitual preference for English practice, adopted the peculiarities of the railway practice of the United States. These Anglo-Canadian engineers and managers asserted that the bogies drew more easily than carriages with rigidly rectangular wheel-bases, and that chilled wheels were equally as safe as, and less expensive in maintenance than, wrought iron wheels."

Mr. J. J. Berckel said: "In Canada the railways had been constructed by English engineers, and they had found it necessary to Americanize the whole of the rolling stock. He knew for a certainty that the leading wheels of the engines sent out from England had been removed and replaced by bogies. . . The explanation of the remarkable results of the author's experiments on train resistances must be sought. *he believed*, chiefly in the looseness of American railway construction. A train that run on rails that yielded readily on its passage, met with less resistance than if the rails were rigid."

NOTE.—This is "an opinion as is an opinion!" We in America never thought of this before. We must go to work and make our new lines more loose and the rails, sleepers, etc., more yielding. "There are millions in it," *if true*. This discovery displays almost as much engineering talent and deep investigation as was shown recently in the columns of the *Otago Times*, or *Australian Engineering News*, or *The London Engineer*, I forget which, when its brain worked out the astounding revelation that the "*bar frame*" in the American locomotive was introduced to give it flexibility !!!

Mr. Berckel went on to say that he had once seen in England an engine, fresh from the erecting shop, that could barely start with 40 lbs. of steam-pressure in the boiler, and this he attributes to very accurate fittings. Good Providence protect us from such accurate fittings; if the builder of this engine had gone a little deeper into accuracy he might have made a wonder of mechanism, one whose power to pull a train "no fellow could find out." W. W. E.

Mr. O. Younghusband said: "The life of the chilled wheel made of Salisbury iron might be safely taken at 150,000 miles. There were some in Canada that had run 160,000 miles, and were still in good order." He then goes on to make some comparisons of cost of English and American wheels, and shows that if the L. & N. W. R'y were to adopt the American wheels that they might save £120,000 a year.

Extracts from the Report of Augustus Morris, Commissioner to the Philadelphia Exhibition in 1876, to the Government of New South Wales.

"I am confident that the construction of American locomotives and rolling stock will enable us more readily to imitate them than the more complicated English patterns. I think I have stated sufficient reasons for concluding that the former have many points of superiority over the latter, and are better suited to colonial requirements.

"The railways of America are remarkably smooth and easy to travel on; serious accidents from defective construction are rare. Not a single accident occurred during the conveyance of the enormous multitudes of people to and from Philadelphia during the Exhibition, which could possibly be charged to the neglect of the officials.

"The manufacturers have produced a locomotive engine which, for simplicity of structure, for power and economy in working, as well as for cheapness, compares most favorably with those of England or Belgium.

"I consulted those eminent engineers who were sent by the Russian, the German, the Austrian, and other European governments, to report on American railway plant, and my conclusions are theirs.

"They gave the preference to the best American locomotives over the English for the requisite qualities."

Extracts from articles by Mr. T. Passavant, Mechanical Engineer, published in the *Glasgow Practical Mechanics' Journal.*

Vol. 2, page 76, Mr. Passavant, in a paper on the construction of locomotives, gives the dimensions of two, one by Sharp, of Manchester, and one by Norris, of Philadelphia. He then gives the daily duty of these engines (the English engine weighed 21½ tons, the American 14 tons), and shows that the duty of the English engine, as compared with the American, was as 1¾ to 1, while the power employed was as 3.9-10 to 1. He then goes on to say:

"The alterations in the construction of locomotives attain their highest value when outside cylinders are employed. A general opinion exists that outside cylinders will not do for high speed ; this may be considered a mere prejudice.

"I have experimented on outside cylinders up to 55 miles an hour, and found them equally as steady as inside cylinders. The outside cylinder engine possesses very great advantages both as regards safety and economy."

Vol. 2, Page 217.—"Such engines as were originally imported from England failed on the American lines; the paying duty bore no just proportion to their absolute power. It was soon seen that to copy English engines would be ruinous to the pecuniary interests of the roads.

"The inventive spirit of the American was roused to build an engine to suit their roads. Experiments were made, principles were developed—now universally adopted, and the engines are enabled to go over arduous, heavy lines with a speed equal to that used in England and with equally heavy trains. Some of these principles would add considerably to the durability and effective power of an English engine, but the latter, as it now is made, would be of very little use on American roads.

"The first great alteration was in 1833, in altering one of Stephenson's engines, by putting a bogie in the place of the leading axle. The engine could then pass, with perfect ease and safety and at its highest speed, through curves on the main track, such as in Europe would not be considered safe even in sidings at stations.

"The next alteration of great importance was the substitution of the straight axle for the crank axle. This, with the truck, completely altered the character of the locomotive. The same genius which thus altered, perceived the necessity for a framing more rigid than the usual one, and an entirely new

construction was introduced, possessing great lateral stiffness. Why was this necessary? On outside cylinder engines being built in England, instead of a stronger, a much weaker frame was used. In England, engines with inside cylinders have always been constructed with two frames on each side; one only carries, but the second one contributes greatly to the lateral stiffness of the whole. This is not necessary, as proved by many such engines being constructed and successfully worked in the United States with only one frame. On the cylinders being placed outside, the engines were found to oscillate much more. To resist this, the only way was to stiffen the engine laterally. This was the object of the new American frame. What was done in England to oppose this injurious tendency? If the causes that produce oscillations had been well understood, the slight plate frames would not have been generally introduced for this class of engines in England.

"For comparison, I will take two engines, No. 1, English, by Sharp, No. 2, American, by McQueen: No. 1 has cylinders, steam-chests, smoke-box, and chimney overhanging the point of support by upwards of three feet. In No. 2, the frame plates are in front themselves, carried by the truck frame, the vertical strain on them being, therefore, less. This support is placed underneath, or very near the center of the cylinders. Overhanging weight there is none; the tendency to oscillation is, therefore, removed. We find, moreover, in No. 1, a rigid leading axle, unavoidably subject to straining in curves, and is one cause of oscillation. In No. 2, we find the truck movable around a center-pin, the wheels and axles adjusting themselves to the curvature, thus removing a great cause of wear and tear and loss of power.

"Were the form of the frame beam the same, with the above points of difference, we should rightly suppose No. 2 a more steady-going engine, but in the construction of these beams itself, we find a better proportioning of material for the purpose for which it is designed in No. 2. The frame of No. 1 is of iron, $8 \times \frac{7}{8}$ inches; its strength to resist a force acting against its sides is 4,044 pounds. The American frame consists of a bar of iron, 2×4 inches; its strength to resist a force acting against its sides is 13,600 pounds. The surplus strength of the English engine in no way contributes to increase the lateral stiffness of the structure. In the American engine, it does altogether.

"Which of these two frames is the most scientific, and, at the same time, the most practical? Of two engines of equal power, which will produce the greatest useful effect? The one that works most easy, and has the least oscillation and strain.

"Which will have the greater durability, and therefore be more economical? The one that possesses greater steadiness of motion.

"Another advantage of the American frame is the saving of expense in material and labor of construction. These are the great principles by which American engineers have successfully attempted to give steadiness, stability, and durability to their engines; the above three qualities of a locomotive, or the three virtues, are solely dependent on a well-constructed frame."

Vol. 3, Page 23. "I gave my views for rendering an outside cylinder engine steady. By reasoning, I came to certain conclusions, which existed simply as theories. Arriving in the United States, I found such engines had been built, that were remarkably steady.

"It may seem bold to place an engine by one of the most renowned firms in England in juxtaposition with one built at a railway work-shop in a town, the name of which is scarcely known in England, but a glance at the drawings will convince the most skeptical how the one must be unsteady, containing within its construction the very cause of oscillation—high boiler, insufficient fastening of cylinders, and great overhanging weight, while the other will move along the road as smooth as possible."

Vol. 3, Page 242. "To start a railway in opposition to the magnificent Hudson River (where the steamers are fitted with a luxurious elegance, which, to the English traveler, was incredible, and when competition had reduced the fare to the lowest standard of profit) was a hazardous undertaking.

"The Hudson River Railway was opened for traffic in 1849. It is crooked, with many quick and serpentine curves, running along the whole distance; the greater part is protected by a river wall. The actual speed of express trains is 44½ miles an hour; for a great part of the line the speed is above 50 miles an hour.

"We have praised the American engines and must expect that the sample we bring will be diligently, perhaps invidiously, compared with English engines, and must be prepared with positive proofs of the excellence of the engines. The accom-

panying drawing of the 'Champlain' represents one of the engines on this railway. . . . She is worthy to be placed by the side of the best English engines, both as to mechanical construction, the duty she has performed, and the elegance of her general design. Her dimensions are: cylinders, 15"x20 inches; four driving wheels, 66 inches diameter; heating surface, 824 square feet; weight of engine, 47,360 pounds; weight on driving wheels, 30,060 pounds. The trains average one baggage and five passenger cars, all the cars on two four-wheeled trucks. The cars have seats for sixty passengers each."

"During the summer we have often seen this engine with from 8 to 11 cars keeping her running time, the cars not merely filled but crowded with passengers. Taking one of their trains, it will weigh 128 tons. This is a heavy train for an engine of that size to propel at 44 miles an hour, on many parts at nearly sixty miles. . . There are many curves on this road such as will not be found on English roads.

"The American passenger engine performs more work. There is more work got out of her than is generally obtained from the English passenger engines. . . . The American passenger engine has many solid advantages in its construction. The almost universal use of double drives is one of them. . . . The above performance of the American engine compares favorably with engines of the same weight by Sharp, which with 40 tons had a speed of 37 miles an hour; but with 70 tons she only attained 26 miles an hour. (See Barlow's description in Tredgold). . . . The use of four-wheeled trucks on engines, tender and cars is a saving of power. . . . It cannot, in opposition, be pretended that the use of trucks is unsafe, when the whole experience of America proves the reverse even at the highest speeds."

NOTE.—The engine Champlain commenced running in December, 1849, and up to March, 1851, had run in 15½ months 46,111 miles. This is at the rate of 35,652 miles for the year. This running gives 114.4 miles for every running day the engine was on this road, which is a continued line of curves with a rigid rock foundation. During these 15 months this engine had to encounter the ice and snow of two New York winters, such as engines in England have never come in contact with. W. W. E.

Vol. 2, page 321. "A paper was read by Mr. Bishop before the Institution of Civil Engineers, describing the American Bogie engines on the Birmingham and Gloucester Railway. He says :

"In a comparative trial of various engines on the inclined plane, an American bogie engine, with cylinders 12.5 inches in diameter, driving wheels 4 feet diameter, weighing 14 tons, conveyed a gross load of 54 tons up the incline at the rate of 12 miles per hour, while the best of the English engines, with 13-inch cylinders, 5-feet driving wheels, and weighing 12 tons, drew 38 tons up the plane at a speed of six miles per hour."

NOTE.—From the above it appears that the merits of the American bogie engine was tried and proved in the very heart of England 42 years ago. The United States Magazine in 1838 published a statement of the above-mentioned engines and their performance in England, and stated that in 1837 the B. & G. Ry. Co. ordered 17 locomotives of Norris. They were sent out in 1838, and after being tried an order was sent for more, but in a few weeks the order was countermanded. The reason given was that the builders of locomotives in England had obtained from the Lords of the Treasury (the Board of Trade, I suppose) a decree forbidding the importation of locomotives into England. W. W. E.

Vol. 3, page 87. "The 4-wheeled truck contrivance, introduced by the Americans, has been found to answer admirably, and is now universally used on their railways.

"Let not then jealousy or vain national pride prevent English engineers copying an American improvement, but rather let us thank them for the invention and confess its excellence by at once adopting it.

"This is not the only point of superiority in American locomotive engines, as may be seen by a perusal of Mr. Passavant's very sensible remarks thereon: 'But it is the principle of the movable truck for carrying the two pairs of leading wheels that I allude to, and which undoubtedly is the simplest and best plan that can be thought of for accommodating the engine to a curved railway. Sound reasoning convinces me that this alteration would be judicious—long practice in America confirms it—and I hope to see it before long followed in England.'

"I consider the American engine-framing to be very soundly constructed, and should be glad to see more attention paid to this in England, being convinced that a stronger frame, in some cases, could be made with less metal, that is, putting the strength where the strain is felt.

"I would principally direct attention to the two fore-mentioned points—the truck for the leading wheels, and a better proportioned framing—believing that by the one alteration the danger of railway traveling may be lessened, and by the other, the power of the locomotive increased."